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Review Article
Historical Note

Turkish Journal of Anaesthesiology & Reanimation

Turk J Anaesthesiol Reanim 2024;52(1):1-7

As the Turkish Journal of Anaesthesiology and Reanimation Leaves Its 50th Anniversary Behind

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Abstract

The Turkish Journal of Anaesthesiology and Reanimation, established in 1972, is 50 years old now. The number of citations of the journal and the interest of national and international researchers are high. This success has been achieved by the editorial boards who have contributed to the journal since its establishment and the writers who have contributed to its development, and this success will continue to increase.

Keywords: Anaesthesiology and Reanimation, History, History of the Turkish Journal of Anaesthesiology and Reanimation, History of TJAR, Turkish Journal of Anaesthesiology and Reanimation

Main Points

- Scientific publications are essential in examining countries' scientific development levels. The Journal of the Turkish Society of Anaesthesiology and Reanimation, established in 1972 has been publishing in the last 50 years.
- The number of citations of the journal and the interest of national and international researchers are high. This success has been achieved by the editorial boards who have contributed to the journal since its establishment and the writers who have contributed to its development, and this success will continue to increase.

Introduction

Scientific publications are essential in examining countries' scientific development levels.[1] The Journal of the Turkish Society of Anaesthesiology and Reanimation, established in 1972 has been publishing in the last 50 years.

The Turkish Journal of Anaesthesiology and Reanimation (Turk J Anaesthesiol Reanim-TJAR) is a periodic scientific publication of the Turkish Society of Anaesthesiology and Reanimation. This editorially independent, unbiased, international journal periodically publishes peer-reviewed work in the anaesthesiology and reanimation field on a global scientific basis. The publication language is English. The journal is published bimonthly in February, April, June, August, October, and December.[2]

The improvement and progress made with the guidance of pioneer physicians of our field in the first hundred years of the Turkish Republic will pave the way and enlighten us in future centuries.

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Main Text

The publishing industry has come a long way, from clay tablets to audiobooks. Scientific publishing has a particular role in this long story. On January 5, 1665, French writer Denis de Sallo, Sieur de la Coudraye (1626 - May 14, 1669) published the first issue of the scientific journal, named "*Journal des sçavans*". Over time, many scientific journals have been published with the developments in science and technology. With the branching out of medicine, anaesthesia has also developed as a main branch of surgery. In the 1950s, throughout the decade, the world continued its recovery from World War II, aided by the post-World War II economic expansion. During this period, anaesthesiologists began to organise worldwide, and associations of anaesthesia were established. The same historical developments have occurred in the Republic of Turkey. Anaesthesiologists Dr. Sadi Sun, Dr. Sabahat Kabaalioğlu and Dr. Cezmi Kınoğlu came together with Surgeons Dr. Şinasi Hakkı Erel and Dr. Fahri Arel to establish "Türk Anestezi Cemiyeti" (TAC) (*Turkish Community of Anaesthesia*) in November 12, 1956.[3] Dr. Fahri Arel has become the first president of the "Turkish Community of Anaesthesia". Two years later, on April 7, 1958, Sadi Sun (1922-1995) was elected president. Later, on January 1, 1969, this society will be named "Türk Anesteziyoloji ve Reanimasyon Cemiyeti (TARC) (*Turkish Community of Anaesthesiology and Reanimation*) parallel to the changes all over the world.[4] There were many attempts to publish a journal in the first 16 years of the community's establishment (Figure 1).

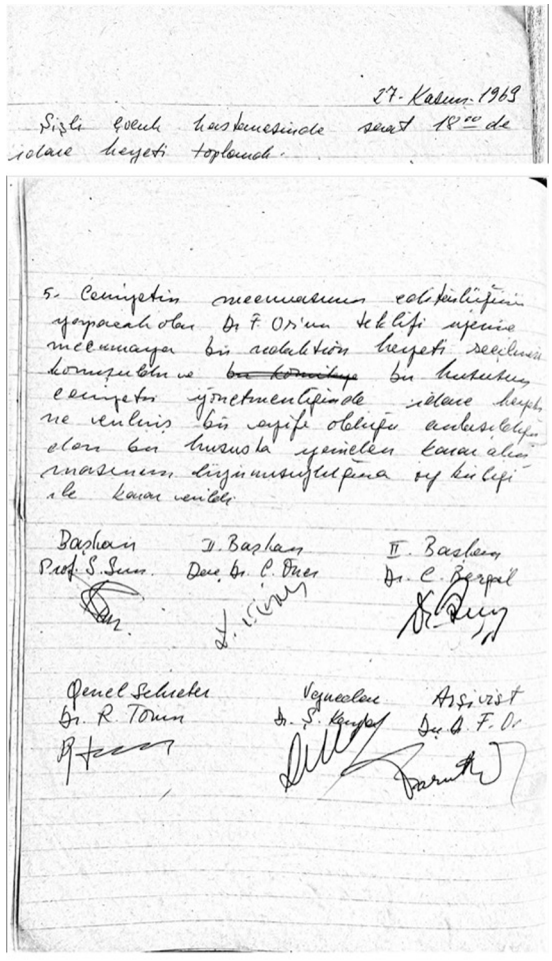

Figure 1. One of the attempts to publish a journal in 1969.

On 27 November 1970, board of the directors of the Turkish Society of Anaesthesiology and Reanimation decided to publish the articles of the national congress and translate the journal of the Middle East Anaesthesia (Figure 2).

On April 21, 1971, the board meeting of Turkish Society of Anaesthesiology and Reanimation was held in Şişli Etfal Children's Hospital, and this historical note was written in the notes of the meeting; "the final preparations of the journal were completed" (Figure 3).

Following these attempts in 1972, 16 years after the establishment of the *Turkish Community of Anaesthesiology and Reanimation*, "Türk Anesteziyoloji ve Reanimasyon Cemiyeti Mecmuası" (*The Journal of Turkish Community of Anaesthesiology and Reanimation)* has been published (Figure 4). During that period, Dr. Sadi Sun, one of the most important pioneers in anaesthesiology and reanimation in Turkey was assigned as the owner of the journal. From 1972 to 1985, Dr. Abdulkadir Erengül was assigned as editor-in-chief in the journal's early years.

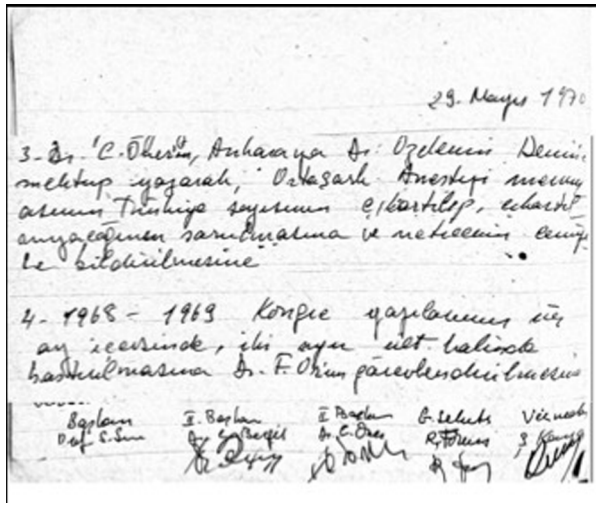

Figure 2. On 27 November 1970, board of the directors decided to publish the articles of the national congress and translate the journal of the Middle East Anaesthesia.

He collected and published the journal using the abstracts, conference contents and some articles and conferences of the previous year national congress. These journals

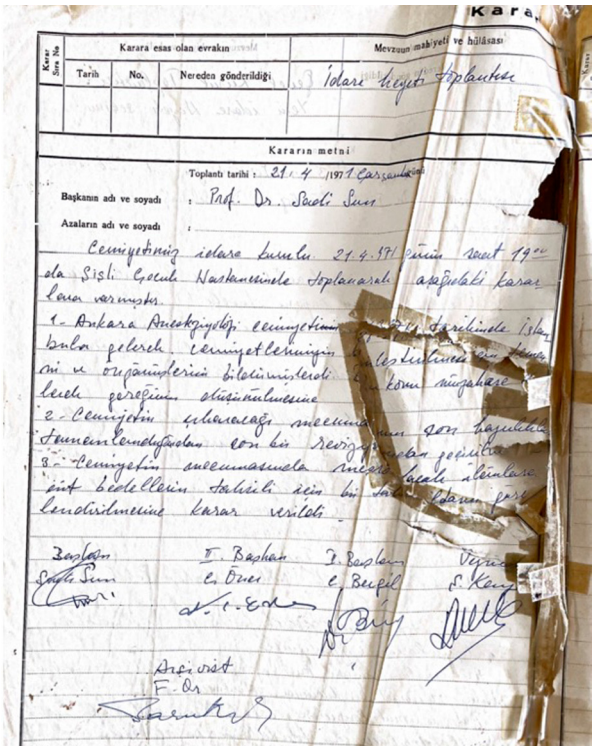

Figure 3. Historical note was written for final preparation of TJAR on April 21, 1971.

TJAR, Turkish Journal of Anaesthesiology and Reanimation

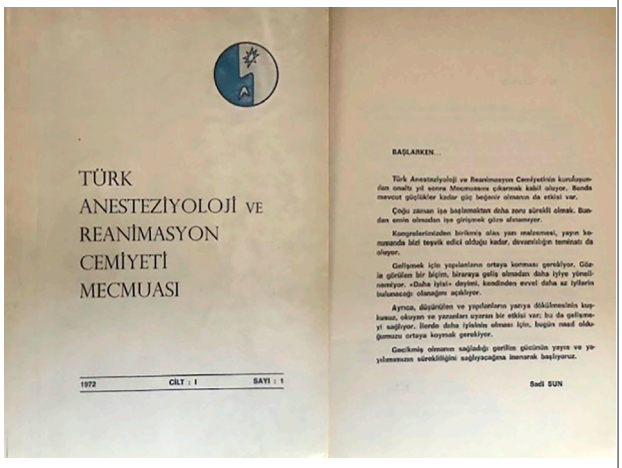

Figure 4. First issue of "The Journal of Turkish Community of Anaesthesiology and Reanimation" in 1972.

were delivered to the members of society during the next congress. During these periods, the journal was published under challenging conditions. Annual volumes were created with several issues of the journal. They were archived in 12 books over 12 years; today, they are available in the society's collection.

Following the social problems that took place in our country in 1980s, significant changes occurred in the law on associations, and after a 5-year silent period, important steps were taken to continue publishing the journal with more systematic and future-oriented projects.

Dr. Sadi Sun has been the president of TARC for 34 years (1958-1994), he assigned Dr. Mois Bahar as editor-in-chief from 1985 until 2002. In the editorial article in the first issue of the 13th volume, Dr. Sadi Sun discussed and narrated their plan (Figure 5).

During this period, the standards and content of the journal have improved to the international level of those years. Articles which will be published in the journal were started to be evaluated by two referees. First, the journal began to be published 4 times a year, then 6, 8 and 10 times a year. Consequently, two supplements were published every available year, and Dr. Bahar professionally collected all journals from the first 17 years.

Another milestone decision can be read in society's history with the president and members on 04.10.1994. Dr. Bora Aykaç (president), Dr. Sadi Sun, Dr. Mois Bahar, Dr. Yılmaz Göğüş, Dr. Gürayten Özyurt, Dr. Uğur Oral, Dr. Hüseyin Öz, Dr. Tahsin Akgün, Dr. G. Aysel Altan, and Dr. Alim Ekinci as a member of TARC have been discussed the future of TJAR (Figure 6).

In this meeting, parallel to the country's regulations changes, it is decided to transfer the publication and legal rights of the journal from the legal entity to the corporate identity of the community. From this date on, president of the TARD began to serve as the owner of the TJAR.

While Dr. Mois Bahar served as an editor-in chief of the TJAR for 17 years, Dr. Sadi Sun (1985-1994), Dr. Bora Aykaç (1994-1996), Dr. Kutay Akpir (1996-1998), Dr. Uğur Oral (1998-2000), Dr. Oya Kutlay (2000-2002) and Dr. Filiz Tüzüner (2002-2003) served as the president of society.

Following these period, on 1 February 2003, the board of directors of TARC approved the historical decision, and the "community" name was changed to the "society", and the magazine (Mecmua) name was changed to the "journal" while Dr. Filiz Tüzüner was president of the society, and Dr. Oya Kutlay was editor-in-chief (Figure 7). In order to adapt the journal into the international scientific world, the English name of the journal started to be used. Then the name of the journal was reorganized, and "Reanimation" word was changed to the "Intensive Care" by the decision of the editorial board. However, this important and current change has not been last long. During these years, manuscripts have been initiated to transition to the e-journal format in order to ensure easy accessibility, increase the reading rate, increase referencing and speed up the Author-Editor-Reviewer process. Also, the journal was available to all members free of charge.

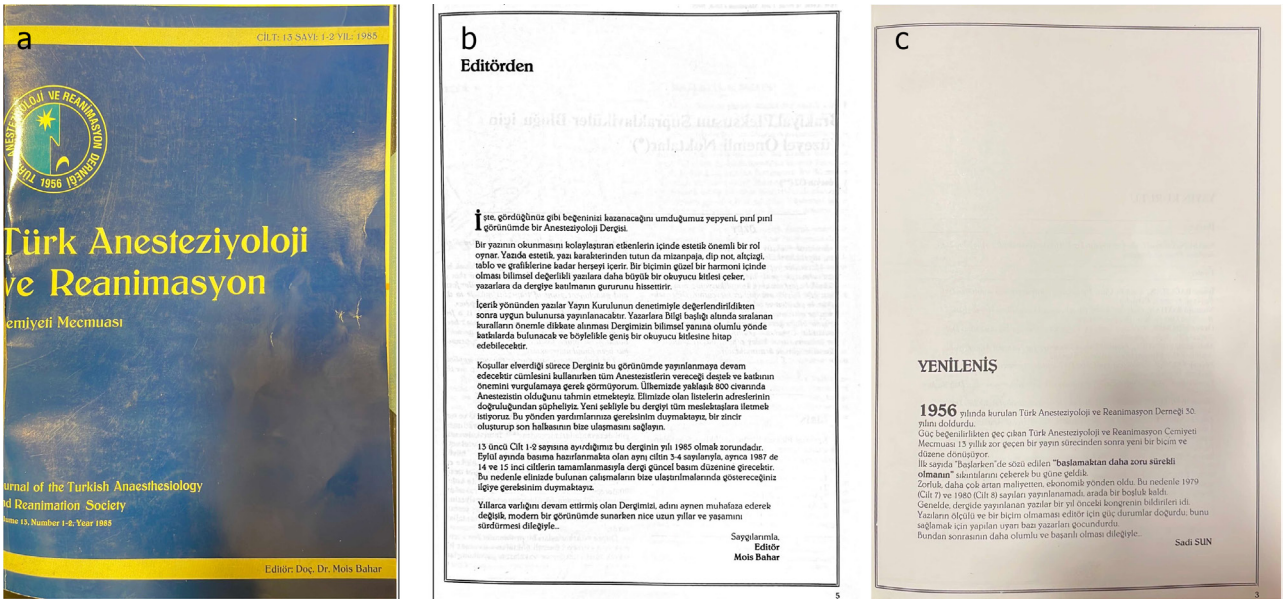

Figure 5. a) Cover Page of the 13th volume of TJAR. b) Editorial article from Prof. Dr. Mois Bahar in 1985. c) Prof. Dr. Sadi Sun discussed and narrated future of the TJAR.

TJAR, Turkish Journal of Anaesthesiology and Reanimation

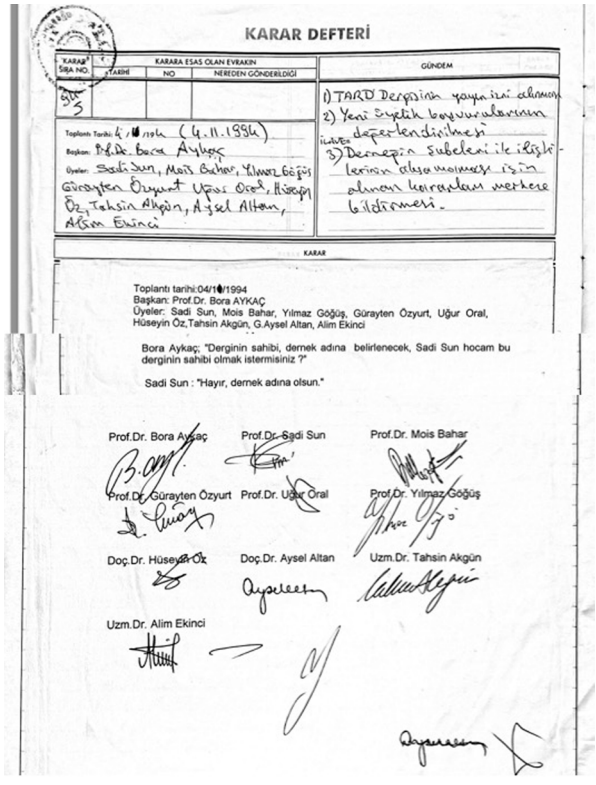

Figure 6. From this date on, president of the TARD began to serve as the owner of the TJAR.

TARD, Turkish Anesthesiology and Reanimation Association; TJAR, Turkish Journal of Anaesthesiology and Reanimation

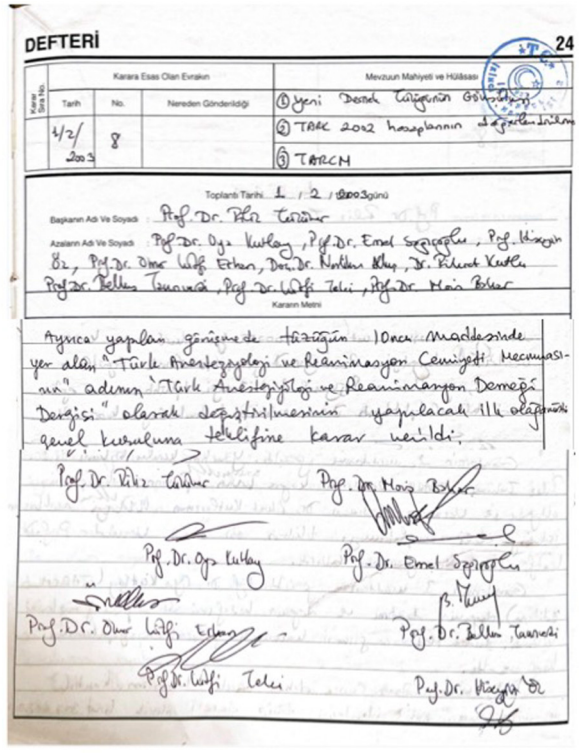

Figure 7. The "community" name was changed to the "society", and the magazine (mecmua) name was changed to the "journal" in February 2003.

In June 2003, the journal was scanned by TÜBİTAK ULAKBİM, a nationally significant database for scientific publication. Another important effort was initiated to include the journal in Index Medicus; however, it failed. During these years, an important step was taken for the future of the journal and an international advisory board was established.

While Dr. Ali Reşat Moral was president of the society, and Dr. Filiz Tüzüner was editor-in-chief, an important step was taken for the future of the journal and an international advisory board was established.

Following millenium, while Dr. Ülkü Aypar was president of the TARD, and Dr. M. Erdal Güzeldemir was editor-in-chief, the journal has become available online. In order to expand the journal's effect zone and increase its scientific level to the international area, the publication language has been changed from Turkish to English.[4] In the following years, editors and editorial boards worked to ensure that the journal was included in internationally accepted indexes. The journal has been scanned in INDEX MEDICUS COPERNICUS since February 2009, in EBSCO since August 2009, in ICMJE since June 2009, and in BRITISH LIBRARY (since 1986).

With these changes over the years, the journal has been progressively prepared for inclusion in an international indexing platform. During Dr. Melek Tulunay's tenure as editor-in chief and Dr. Şükran Şahin's presidency of the society (2010-2012), these structural changes continued, and the necessary requirements for the journal to be included in international indexes were fulfilled.

Over the years, technological changes have been reflected to the journal, and official website was activated in January 2012. During these period, Dr. Güner Kaya was the president of society and, Dr. Yalım Dikmen was editor-in-chief of TJAR. In September 2012, in order to improve the impact factor of the journal, and in accordance with the regulatory rules of the international scientific indexing databases, the name of the "society" was removed from the name of the "Turkish Journal of Anaesthesiology and Reanimation" by the decision of the editorial board.[4]

2013 was a turning point in terms of the results of many years of work, then the journal met the indexing criteria by PubMed Central and the Web of Science-Emerging Sources Citation Index (ESCI). Dr. Yalım Dikmen was editor-in chief, and Dr. Güner Kaya was the president of TARD at that time. After this period, the number and scientific level of submitted manuscripts increased significantly (Figure 8).

Between 2016 to 2018, while Dr. N. Mert Şentürk was served as the editor-in chief of the TJAR and, Dr. Hülya Bilgin as the president of TARD, "debate articles" and "forums"

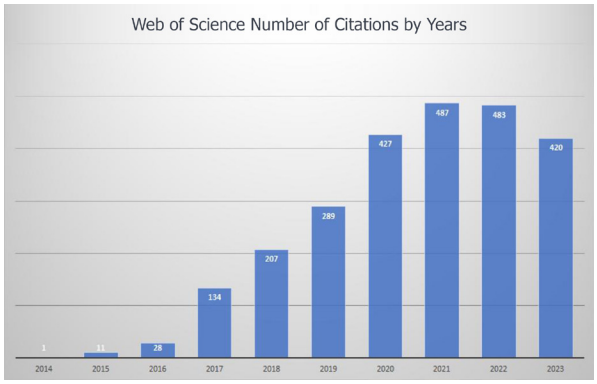

Figure 8. Citations per year (Web of Science).

from experts were published to enhance the journal's impact factor. These articles were widely referenced across various platforms. Additionally, one of these articles was submitted by the World Federation of Societies of Anesthesiologists as a reference to the World Health Organization. By the end of 2018, significant increases in the impact factor were observed, leading to the journal being ranked as the 5th best journal in ESCI (0.637).

Later on, accessibility and organizational capacity were expanded during Dr. Yalım Dikmen's tenure as editor-in chief again. Subsequently, Dr. Ömer Kurtipek (2018-2021) and then Dr. Meral Kanbak (2021-2023) served as the president of society.

Article Processing Charges (APCs) was started to charge to authors during the publication process since January 2023, while Dr. Aslı Dönmez was editor-in chief of TJAR, and Dr. Ali Fuat Erdem was the president of the society. In January 2024, Dr. Zekeriyya Alanoğlu assigned as editor-in-chief of TJAR following Dr. Dönmez.

Today, it is published bimonthly in February, April, June, August, October, and December, and indexed by national and international databases such as PubMed Central, ESCI, Scopus, DOAJ, TÜBİTAK ULAKBİM-TR Index, China National Knowledge Infrastructure, EMBASE, EmCare, CINAHL, ProQuest ve Gale. Recently, social media has become an essential tool in the world of journals. It allows journals to promote their work and helps them connect with their readers and stay up to date with the latest research in their field. TJAR has social media accounts on instagram (@turkishjar) (2022), facebook (Tjar-Tjar) (2022), and X platform (j_turkish) (2019).

As we celebrate the first 100th anniversary of the Republic of Turkey, Turkish Journal of Anaesthesiology and Reanimation is a well-known journal of high scientific quality which results from outstanding efforts of its Editor-in-chiefs, editorial boards, reviewers and authors (Table 1, Figure 9).

Table 1. Editor-in-Chiefs of the TJAR

Period	General Assembly Date	President of TARD	Period	Editor-in-Chiefs of TJAR
1956-1958	12.11.1956	Prof. Dr. Fahri Erel		
1958-1972	07.04.1958	Prof. Dr. Sadi Sun (1922-1995)		
1972-1985	**Repeated in every 2 years**	Prof. Dr. Sadi Sun	1972-1985	Prof. Dr. Abdulkadir Erengül (1927-2012)
1985-1994	**Repeated in every 2 years**	Prof. Dr. Sadi Sun	1985-1994	Prof. Dr. Mois Bahar
1994-1996	26.03.1994	Prof. Dr. Bora Aykaç	1994-1996	Prof. Dr. Mois Bahar
1996-1998	27.01.1996	Prof. Dr. Kutay Akpir (1943-2013)	1996-1998	Prof. Dr. Mois Bahar
1998-2000	07.03.1998	Prof. Dr. Uğur Oral	1998-2000	Prof. Dr. Mois Bahar
2000-2002	26.02.2000	Prof. Dr. Oya Kutlay	2000-2002	Prof. Dr. Mois Bahar
2002-2004	31.03.2002	Prof. Dr. Filiz Tüzüner	March 2002-December 2002	Prof. Dr. Mois Bahar
			January 2003-March 2004	Prof. Dr. Oya Kutlay
2004-2006	13.03.2004	Prof. Dr. Mois Bahar	2004-2005	Prof. Dr. Oya Kutlay
2006-2008	19.03.2006	Prof. Dr. Ali Reşat Moral	2006-2008	Prof. Dr. Filiz Tüzüner
2008-2010	23.03.2008	Prof. Dr. Ülkü Aypar	2008 -2010	Prof. Dr. M. Erdal Güzeldemir
2010-2012	21.03.2010	Prof. Dr. Şükran Şahin	2010-2012	Prof. Dr. Melek Tulunay (1948-2015)
2012-2014	11.03.2012	Prof. Dr. Güner Kaya	2012-2014	Prof. Dr. Yalım Dikmen
2014-2016	16.03.2014	Prof. Dr. Neslihan Alkış	2014-2016	Prof. Dr. Yalım Dikmen
2016-2018	27.03.2016	Prof. Dr. Hülya Bilgin	2016-2018	Prof. Dr. N. Mert Şentürk
2018-2021	25.03.2018	Prof. Dr. Ömer Kurtipek	2018-2021	Prof. Dr. Yalım Dikmen
2021-2023	21.03.2021	Prof. Dr. Meral Kanbak	2021-2022	Prof. Dr. Yalım Dikmen
			2022-2023	Prof. Dr. Aslı Dönmez
2023-2025	12.03.2023	Prof. Dr. Ali Fuat Erdem	2023-2024	Prof. Dr. Aslı Dönmez
			2024-	Prof. Dr. Zekeriyya Alanoğlu

Figure 9. Editor in-Chiefs of the Turkish Journal of Anaesthesiology and Reanimation since its establishment in 1972.

Conclusion

The Turkish Journal of Anaesthesiology and Reanimation (TJAR) is a peer-reviewed open access journal that meets high quality standards by exercising peer review and editorial quality control. This success has been achieved by the editorial boards who have contributed to the journal since its establishment and the writers who have contributed to its development, and this success will continue to increase. We wish many productive 50 years to TJAR to contribute to the scientific world.

Acknowledgements

The authors have endless gratitude for Prof. Dr. Bora Aykaç, Prof. Dr. Oya Kutlay, Prof. Dr. Filiz Tüzüner, Prof. Dr. Ülkü Aypar, Prof. Dr. M. Erdal Güzeldemir, Prof. Dr. Şükran Şahin, Prof. Dr. Güner Kaya, Prof. Dr. Neslihan Alkış, Prof. Dr. Ömer Kurtipek, Prof. Dr. Meral Kanbak, Prof. Dr. Yalım Dikmen, and Prof. Dr. N. Mert Şentürk who have shared their knowledge for this article.

Also, the authors thanks to the Prof. Dr. Hülya Bilgin for her great contributions to the research on the history of Turkish Anaesthesiology and Reanimation.

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Ethics

Author Contributions: Concept - H.T.; Design - H.T.; Data Collection or Processing - H.T.; Analysis or Interpretation - H.T., Ö.K., A.D.; Literature Search - H.T., Ö.K., A.D.; Writing - H.T.; Critical Review - H.T., Ö.K., A.D., E.A., M.B.

Declaration of Interests: The authors have no conflict of interest to declare.

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Original Article
Perioperative Care

Turkish Journal of Anaesthesiology & Reanimation

Turk J Anaesthesiol Reanim 2024;52(1):8-13

Visual Evaluation of Plethysmographic Waveforms: Introducing the Simple Systolic Ratio as an Indicator of Fluid Responsiveness

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Abstract

Objective: For patient safety, maintaining hemodynamic stability during surgical procedures is critical. Dynamic indices [such as systolic pressure variation (SPV) and pulse pressure variation (PPV)], have recently seen an increase in use. Given the risks associated with such invasive techniques, there is growing interest in non-invasive monitoring methods-and plethysmographic waveform analysis. However, many such non-invasive methods involve intricate calculations or brand-specific monitors. This study introduces the simple systolic ratio (SSR), derived from pulse oximetry tracings, as a non-invasive method to assess fluid responsiveness.

Methods: This prospective observational study included 25 adult patients whose SPV, PPV, and SSR values were collected at 30-min intervals during open abdominal surgery. The SSR was defined as the ratio of the tallest waveform to the shortest waveform within pulse tracings. The correlations among SSR, SPV, and PPV were analyzed. Additionally, anaesthesia specialists visually assessed pulse oximetry tracings to determine fluid responsiveness using the SSR method.

Results: Strong correlations were observed between SSR and both SPV ($r = 0.715$, $P < 0.001$) and PPV ($r = 0.702$, $P < 0.001$). Receiver operator curve analysis identified optimal SSR thresholds for predicting fluid responsiveness at 1.47 for SPV and 1.50 for PPV. A survey of anaesthesia specialists using the SSR method to visually assess fluid responsiveness produced an accuracy rate of 83%.

Conclusion: Based on the strong correlations it exhibits with traditional markers, SSR has great potential as a clinical tool, especially in resource-limited settings. However, further research is needed to establish its role, especially as it pertains to its universal applicability across monitoring devices.

Keywords: Cancellation, elective surgeries, perioperative care, preoperative assessment, surgery scheduling

Main Points

- This prospective observational study introduces the simple systolic ratio (SSR) from pulse oximeter tracings as a non-invasive method to assess fluid responsiveness during surgery.
- SSR is defined as the ratio of the tallest waveform to the shortest waveform within the pulse tracings.
- Twenty five adult patients undergoing open abdominal surgery were observed, comparing SSR with the traditional markers systolic pressure variation (SPV) and pulse pressure variation (PPV).
- Strong correlations were found between SSR and both SPV ($r = 0.715$) and PPV ($r = 0.702$).
- Receiver operator curve analysis identified the optimal SSR threshold for predicting fluid responsiveness as 1.50.
- A survey with anaesthesia specialists demonstrated an accuracy rate of 83% in visually assessing fluid responsiveness using the SSR method.

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Introduction

Hemodynamic stability during surgical procedures is vital for patient safety. Maintaining optimal intravascular volume and ensuring proper fluid therapy are especially crucial during open abdominal surgery. In recent years, dynamic indices, such as systolic pressure variation (SPV) and pulse pressure variation (PPV), have become essential tools for assessing the fluid responsiveness of intubated patients.[1,2] Although these parameters provide valuable insights, their invasive nature may not be suitable or feasible for every patient or monitoring apparatus.

Given the challenges and potential complications associated with invasive methods, there is growing interest in non-invasive monitoring techniques. In particular, plethysmographic waveform analysis is a promising method for assessing fluid status in patients.[3-5] Although numerous indices derived from plethysmographic waveforms can forecast fluid responsiveness, their practical application is often hindered by the need for intricate computations, specialized algorithms, or brand-specific monitors, which curtail their universal applicability and adoption across diverse clinical settings.

Several of the aforementioned indices employ formulas based on the amplitudes of the plethysmographic waveforms. A closer inspection of these formulas reveals an underlying simplicity: they center predominantly around contrasting the amplitude of the tallest waveform with that of the shortest. Despite being cloaked in complex terminology and mathematical representations, the essence of these methods can be distilled to a basic ratio of the tallest wave to the shortest wave in the waveform.

A widely recognized index derived from plethysmography waveform analysis is the pulse oximetric plethysmographic (POP) waveform amplitude index,[6] which is described by the following formula:

$$POP = \frac{POP_{max} - POP_{min}}{\frac{POP_{max} + POP_{min}}{2}}$$

In this formula, POP_{max} and POP_{min} represent the heights of the tallest and shortest waves , respectively. By introducing a variable, R (where R is the ratio of POP_{max} to POP_{min} (POP_{max}/POP_{min}), and rearranging the formula accordingly, it becomes evident that the POP formula essentially translates to R accompanied by some constants ($POP = 2R-2/R+1$), highlighting that the core of the formula lies not in the absolute values of POP_{max} and POP_{min} but in their comparative relationship. Consequently, simply measuring the ratio R may suffice in making predictions similar to those made by the POP index.

Furthermore, direct visual interpretation of the plethysmographic waveform to estimate the ratio R, which is referred to as the simple systolic ratio (SSR) in this study, without relying on specialized tools or intricate calculations, may offer insights comparable to advanced methods. SSR is closely linked to the POP index because it is derived from the same formula and can reflect dynamic changes during the respiratory cycle as the POP index does.[6] By simplifying the formula used in POP measurements, SSR was developed to provide a straightforward yet effective approach, free from the constraints of brand-specific equipment and complex calculations. Such a method is particularly valuable in resource-limited settings, including developing countries and remote areas, as it provides clinicians with a practical tool for monitoring hemodynamic changes during surgeries.

The central hypothesis of this study is that SSR is correlated with the established fluid responsiveness parameters SPV and PPV and can therefore be used as a non-invasive monitoring technique to assess fluid responsiveness. This investigation validates SSR against these conventional metrics and assess its practical utility in clinical settings. A key focus is to determine the feasibility of anaesthesia professionals to visually discern fluid responsiveness by interpreting SSR.

Methods

Ethical approval for this prospective observational study was granted by the Koç University Hospital Clinical Research Ethics Committee (approval no: 2020.439.IRB1.162, date: 26.11.2020).

A cohort of 25 adult patients scheduled for open abdominal surgery was enrolled and participated in this study. The primary inclusion criterion for the study was imminent open abdominal surgery, with patients included only when the attending anaesthesiologist deemed invasive arterial pressure monitoring medically necessary. Informed consent was obtained from all study participants.

To eliminate potential confounders, the following exclusion criteria were established:

1. Refusal to participate. Patients from whom informed consent was not obtained were excluded from the study.

2. Presence of advanced cardiac disease. Patients with a history of (or current) severe cardiac disease that could affect hemodynamic parameters or their interpretation were excluded from the study. Advanced cardiac disease was defined as anyone or both of the following parameters:

- An ejection fraction <35%, as assessed by echocardiography;
- Class III/IV heart failure, as defined by the New York Heart Association.

3. Presence of rhythm abnormalities. Because cardiac rhythm disturbances can affect the accuracy of plethysmographic waveforms and other derived parameters, patients with arrhythmias or any significant rhythm abnormalities were excluded from the study.

4. Presence of pulmonary hypertension. Because pulmonary hypertension can introduce changes in hemodynamic response and could confound the interpretation of plethysmographic waveforms, patients with a mean pulmonary arterial pressure >25 mmHg at rest, as measured by right heart catheterization or echocardiography, were excluded.

5. Use of vasoactive medications. Patients on medications that significantly influence vascular tone and hemodynamics were not considered suitable for this study.

Screen captures from anaesthesia monitors (Datex-Ohmeda CARESCAPE B850; GE Healthcare; Chicago, IL) were taken at 30-min intervals while patients underwent surgery. SPV and PPV values were extracted from this screen captures by a researcher who then isolated the plethysmography waveform from each capture to create new image files. To maintain objectivity and ensure blindness, a researcher who was uninformed about the previously extracted data was subsequently tasked with employing pixel counts to compute SSR values from the new image files. The SSR was defined as the ratio of the tallest waveform to the shortest waveform within pulse tracings (Image 1).

Statistical Analysis

The normal distribution of each variable was evaluated using the Kolmogorov-Smirnov test. Variables adhering to a normal distribution are summarized as means and standard deviations. Variables that demonstrated a non-normal distribution are summarized as median and range.

The correlations between SSR, SPV, and PPV values were assessed using Spearman or Pearson correlation analysis based on the normal or non-normal distribution of the variables.

To determine diagnostic accuracy and the threshold value of SSR in predicting fluid responsiveness, two receiver operator curve (ROC) analyses were performed: one each for SPV and PPV as the determinant of the state variable. In the first ROC analysis, an SPV value of 10 was used as the threshold.[7] Cases where the SPV was equal to or exceeded 10 were categorized as "1", and cases where the SPV was below 10 were categorized as "0". This state variable and the SSR values were used to create an ROC curve, which was used to analyze the SSR's ability to diagnose these cases accurately. Similarly, in the second ROC analysis, a PPV value of 15 served as the threshold.[8] Cases with PPV values of 15 or higher were categorized as "1", and a ROC curve was created using this state variable and SSR values. The optimal threshold for SSR was determined by calculating the value that maximized the equation (sensitivity + specificity)/2 for each of the two ROC analyses separately.

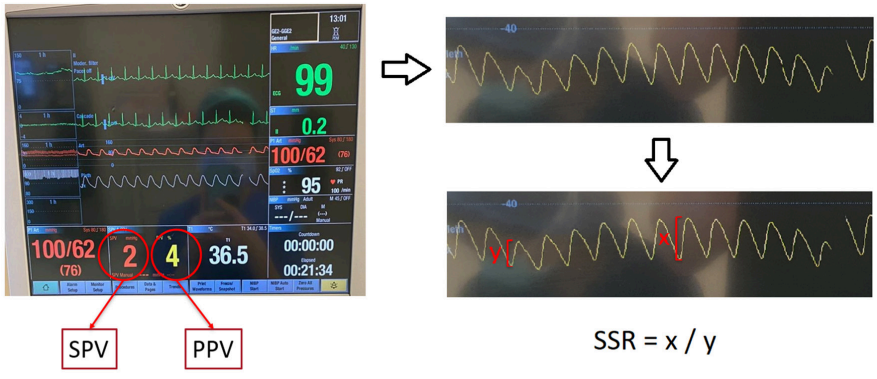

Image 1. Process of data extraction from screen images.

SSR, simple systolic ratio; SPV, systolic pressure variation; PPV, pulse pressure variation.

Table 1. Summaries of SSR, SPV and PPV Measurements

	Median	Minimum	25th percentile	75th percentile	Maximum
SSR	1.34	1.04	1.19	1.56	2.68
SPV	6	1	4	8	12
PPV	9	1	6	14	35

All data analyses were performed using SPSS v. 24.0 statistical software. Results were considered statistically significant at $P < 0.050$.

In a separate segment of the study, 20 pulse oximetry tracings with SSR values ranging from 1.09 to 2.12 were presented to anaesthesia specialists, who were asked to visually assess the waveforms and decide whether the SSR of the waveform was greater than the threshold established in the ROC analysis. The accuracy of the answers provided in the survey was then compared with the preestablished SSR values. The purpose of this survey was to evaluate the ability of anaesthesia specialists to visually estimate fluid responsiveness using the SSR method.

A sample size analysis was conducted before patient recruitment. The analysis was based on the following parameters: α (two-tailed) = 0.05, β = 0.10, and an expected correlation coefficient (r) of 0.60. The selection of a correlation coefficient of 0.60 was based on the prediction of a moderate to strong correlation between the SSR and both SPV and PPV, owing to the underlying mathematical equivalence of POP and SSR and previously established correlations between POP and SPV. In Addison et al.,[9] various signal processing algorithms applied to POP yielded correlation coefficients ranging from 0.35 to 0.85 with SPV. A coefficient of 0.60 was chosen to represent a moderate value within this range, aligning with the expected correlation strength for the purposes of this study. Based on these parameters, the sample size analysis indicated that a sample size of 25 would be sufficient to reliably detect and validate the proposed correlations.

Results

The study consisted of 13 male and 12 female patients with an average age of 54 years [range: 38-70 y, standard deviation (SD): 10.6]. The mean body mass index of the participants was 26.4 kg m^{2-1} (range: 20.5-32.8 kg m^{2-1}, SD: 3.9). The primary indications for surgery among study participants included gastrointestinal tumors (n = 12), hernias (n = 7), and other abdominal pathologies (n = 6). All patients had an American Society of Anesthesiologists physical status score of II or III.

A total of 117 screen captures were obtained during the open abdominal surgeries of the study participants. For each screen capture, the SSR, SPV, and PPV values were successfully extracted without any data loss.

The Kolmogorov-Smirnov test revealed that the SSR, SPV, and PPV data did not follow a normal distribution (Table 2). Spearman correlation analysis revealed a strong correlation between SSR and SPV, with a correlation coefficient (r) of 0.715. This result was statistically significant ($P < 0.001$), suggesting a strong positive relationship between the two parameters (Table 2). Similarly, a strong correlation was observed between SSR and PPV, with a correlation coefficient of 0.702. This result was also statistically significant ($P < 0.001$) (Table 2).

Table 2. Spearman's Correlation Analysis of Simple Systolic Ratio, Systolic Pressure Variation, and Pulse Pressure Variation

		SSR	SPV	PPV
SSR	Correlation coefficient	1.000	0.715**	0.702**
	Significance (two-tailed)	-	<0.001	<0.001
SPV	Correlation coefficient	0.715**	1.000	0.826**
	Significance (two-tailed)	<0.001	-	<0.001
PPV	Correlation coefficient	0.702**	0.826**	1.000
	Significance (two-tailed)	<0.001	<0.001	-

**Statistically significant correlations
SSR, simple systolic ratio; SPV, systolic pressure variation; PPV, pulse pressure variation

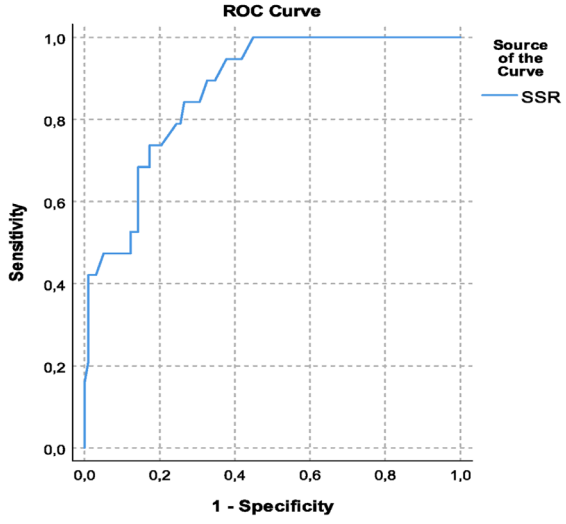

Image 2. Systolic pressure variation based receiver operating characteristic curve analysis of simple systolic ratio.

SSR, simple systolic ratio; ROC, receiver operating characteristic.

The first ROC analysis of SSR values, conducted using SPV values as the determinant of the state variable, yielded an area under the curve of 0.873 with a standard error of 0.037 ($P > 0.001$) and an optimal SSR threshold of 1.47 with a Youden's J index of 0.577 (Image 2). In predicting elevated SPV values, SSR exhibited a sensitivity of 83% and specificity of 74% at this threshold.

The second ROC analysis of SSR values, conducted using PPV values as the determinant of the state variable, yielded

an area under the curve of 0.890 with a standard error of 0.033 ($P > 0.001$) and an optimal SSR threshold of 1.50 with a Youden's J index of 0.722 (Image 3). Applying this threshold, SSR registered a sensitivity of 89% and specificity of 83%.

Given the proximity of the optimal SSR thresholds identified for SPV and PPV, a pragmatic approach for the survey was adopted, in which the SSR threshold was unified at 1.50. This decision was motivated by the desire to facilitate the task set out for the survey participants. Asking participants to determine whether a ratio surpassed a specific value, such as 1.47, would have been logistically challenging and potentially imprecise; therefore, the rounded-off value of 1.50 was chosen as the uniform SSR threshold for the survey, ensuring a more straightforward and feasible query for the participating anaesthesia experts.

During the survey of anaesthesia experts, each of the 28 experts was presented with a set of 20 plethysmographic waveforms, the variations of which represented SSR values ranging from 1.09 to 2.12. The participants' primary task was to visually inspect each waveform and determine whether the ratio of the tallest waveform to the shortest surpassed the 1.5 SSR threshold established by the earlier ROC analysis.

Of the 560 responses gathered (28 × 20), 467 were correct, representing an overall accuracy rate of 83%. However, it was observed that for waveforms with an SSR value between 1.38 and 1.6, the accuracy rate dropped to 55%. Conversely, for waveforms that fell outside this range, the accuracy rate climbed to 95% (Image 4).

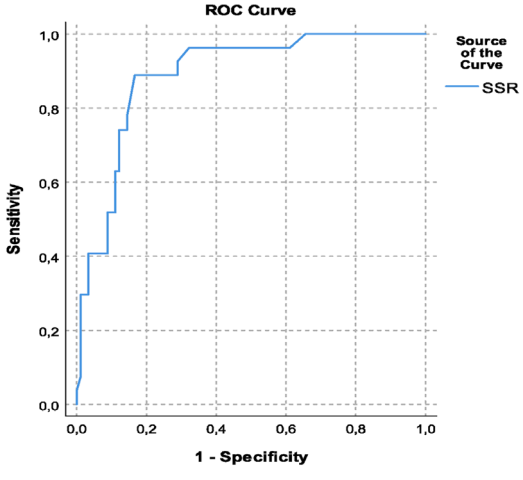

Image 3. Pulse pressure variation based receiver operator curve analysis of simple systolic ratio.

SSR, simple systolic ratio; ROC, receiver operating characteristic.

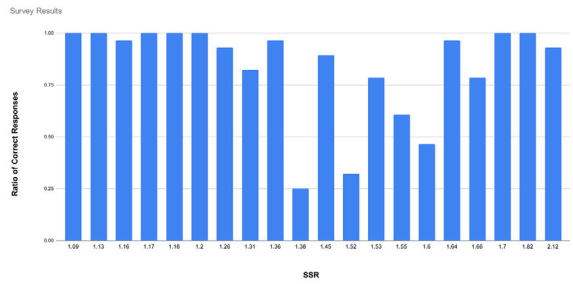

Image 4. Results of the survey of anesthesia experts.

SSR, simple systolic ratio.

Discussion

The primary aim of this study was to explore the feasibility and accuracy of SSR as a non-invasive tool for determining fluid responsiveness in patients undergoing open abdominal surgery. The studys findings provide substantial evidence supporting the efficacy of SSR in this role.

A significant correlation between SSR and both SPV and PPV emerged during the analysis, suggesting that SSR could serve as an effective surrogate marker for these established indicators. Given that SPV and PPV have long been upheld as reliable markers of fluid responsiveness, the strong association between SSR and these indices further underscores the potential of SSR as a valuable clinical tool.

Pulse oximetry sensors and monitors use digital filters to refine and clarify plethysmographic waveforms, ensuring that clinicians receive readable and consistent signal.[10,11] However, the exact specifications and characteristics of these filters can vary significantly across different sensors and monitor brands. Consequently, the SSR threshold determined in this study may not be universally applicable across devices. Clinicians should exercise caution before adopting the 1.5 threshold globally, as it could lead to misinterpretations and potential clinical errors. Rather than relying on specific values at isolated time points, observing SSR trends over time may offer a more reliable and holistic insight into patients' fluid responsiveness. To better define device-specific thresholds and refine the use of SSR, additional research involving various monitors and sensors is required to capture the broad spectrum of technology currently in clinical use.

This study illuminated the potential of straightforward visual assessment of plethysmographic waveforms as a powerful indicator of fluid responsiveness; however, it also revealed challenges, particularly in recognizing SSR values near the chosen threshold. While overall accuracy registered at 83%, this dropped to 55%, which is close to the established threshold. Nevertheless, this limitation may

be easily mitigated by temporarily freezing the monitor's display when in doubt and enlisting the help of a simple ruler to measure the tallest and shortest waves. This approach can increase the reliability of the SSR method, making it a valuable tool in resource-constrained environments where sophisticated hemodynamic monitoring equipment may be scarce.

Study Limitations

This study was based on a relatively small sample size of 25 patients undergoing similar surgeries and thus may not be representative of the broader population.

This study used SPV and PPV as reference indices; however, no single index is perfect, and another index may offer a different perspective on the effectiveness of SSR. This study used a specific pulse oximeter and monitor. Because different monitors and sensors may have unique digital filters that affect plethysmographic waveforms, the study's findings may not be directly applicable to devices from other manufacturers.

Conclusion

This study shows the potential of SSR as an efficient, non-invasive tool for assessing fluid responsiveness through visual analysis of plethysmographic waveforms. Further research and validation across diverse clinical contexts will be instrumental in establishing the role of SSR in routine clinical practice.

Ethics

Ethics Committee Approval: Ethical approval for this prospective observational study was granted by the Koç University Hospital Clinical Research Ethics Committee (approval no: 2020.439.IRB1.162, date: 26.11.2020).

Informed Consent: Informed consent was obtained from all study participants.

Author Contributions: Concept - M.S.S., K.D., Y.G.; Design - M.S.S., K.D., M.A.K., M.M., Y.G.; Data Collection or Processing - M.S.S., M.M.; Analysis or Interpretation - M.S.S.; Literature Search - M.A.K., M.M.; Writing - M.S.S., K.D., Y.G.

Conflict of Interest: The authors have no relevant financial or non-financial interests to disclose.

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Prevalence and Causes of Elective Surgery Cancellations After Patients are Taken to the Operating Room: A Prospective, Cross-Sectional Study

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Abstract

Objective: This study aimed to investigate the causes and prevalence of elective surgery cancellations in the operating room, and the clinical outcomes of affected patients.

Methods: This prospective, cross-sectional study assessed the prevalence and causes of elective surgery cancellations once patients are in the operating room. A tertiary academic referral center hosted the study between January 2022 and January 2023. The study sample consisted of 7,482 adult patients scheduled for elective surgeries and taken to the operating room. The 7,415 completed procedures were in Group 2, whereas the 67 cancelled surgeries were in Group 1. Patients were divided into two groups on the basis of whether their surgeries were completed or cancelled. Factors such as age, American Society of Anesthesiologists (ASA) status, and surgical department were analyzed. The two groups were compared on the basis of age, ASA status, surgical department, and surgery time (month and day).

Results: Elective surgery cancellations occurred in the operating room at a rate of 0.9%. Group 1 was substantially older than Group 2 ($p<0.001$). Group 1 had a larger number of ASA III patients ($p<0.001$). The department with the highest cancellation rate was ophthalmology (2.5%), followed by general surgery (2.1%), urology (1.5%), and ear, nose, and throat (1.4%). It was possible to avoid 59.7% of cancelations.

Conclusion: The study revealed a 0.9% prevalence rate of elective surgery cancelations in the operating room. Older age and higher ASA status greatly influenced these cancellations. Optimized surgery scheduling and patient assessment processes may prevent many of these cancellation.

Keywords: Cancellation, elective surgeries, surgery scheduling, perioperative care, pre-operative assessment

Main Points

- The study shows a 0.9% rate of elective surgery cancellations after operating room patient arrival.
- Elderly and high American Society of Anesthesiologists classes have a greater risk of elective surgery cancellations.
- Most cancellations in ophthalmology (2.5%), followed by gen surgery (2.1%) and urology (1.5%).
- 59.7% of cancellations are potentially avoidable, highlighting pre-op assessment flaws.
- Suggestions: better patient awareness, improved communication, and detailed preoperative checks.

Introduction

Cancellations of scheduled elective surgeries reduce the operating room efficiency, increase the anxiety of the patients to be operated on as well as their families, lead to ineffective use of human resources and surgical supplies, and adversely impact overall health-related quality measures.[1,2] Cancellations of scheduled elective surgeries also impose an extra financial burden on the healthcare system.[3] The use of an organized multidisciplinary approach or

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a preoperative outpatient-based clinic has been associated with reduced rates of elective surgery cancellations.[1]

Various reasons, such as inadequate preoperative assessment, patient-related factors, underlying chronic diseases, and administrative or organizational issues, have been proposed for cancelling elective surgeries.[2,4] Identifying the factors that cause the cancellation of elective surgeries is important in determining the appropriate strategies for improving patient satisfaction, operating room resources, and perception of quality of care.[5] It has been stated that most of the reasons given for elective surgery cancellations could be prevented or potentially avoided via early assessment and meticulous planning and coordination before the patients to be operated on were hospitalized.[1,5-7]

The date an elective surgery is cancelled varies between the day the patient is notified of the scheduled surgery date and the day the surgery is scheduled to be performed. Unexpected cancellation of a surgery as late as the day the surgery is scheduled to be performed or even after the patient to be operated on is taken to the operating room has a more significant negative impact on hospital resources than cancellation of the surgery before the date it is scheduled to be performed.[6,8] The emotional trauma experienced by patients and their families due to surgery cancellations is another negative result.[9,10] Cancellation of elective surgery after the patient is taken to the operating room causes extra emotional distress in patients, in addition to unnecessary costs and ineffective use of hospital resources.[11,12]

There is limited data in the literature on the cancellation of elective surgeries once the patient is taken to the operating room. These cancellations can be reduced by determining the reasons for cancellation. In this context, this study was conducted to determine the prevalence and causes of cancellations of elective surgeries once the patient is in the operating room and the clinical course of the patients subject to surgery cancellation.

Methods

Study Design

The population of this prospective, cross-sectional study consisted of adult patients (aged 18 years or older) scheduled to undergo elective surgery between January 2022 and January 2023 at a tertiary academic referral center and taken to the operating room. The study protocol was approved by the Süleyman Demirel University Faculty of Medicine, Ethical Committee for Clinical Studies before the study (approval no: 3/33, date: 26.01.2022). The study was conducted in accordance with the principles outlined in the Declaration of Helsinki. Written informed consent was obtained from all patients.

Study Setting

The tertiary academic referral center where the study was conducted is located in the Isparta Province in the Mediterranean Region of Turkey. According to 2022 statistics, the population of the province is 445,325. The center has 595 inpatient beds. A total of 34,658 medical and surgical patients were hospitalized at the center in 2022. The center has 18 operating rooms used by different departments. The regular working hours of the operating rooms are 8-AM to 4 PM on weekdays, except for public holidays.

Patient Groups

Of the patients included in the study population, those who underwent emergency, obstetric, or minor elective surgeries that did not require preoperative filling out anaesthesiology assessment sheets and those who were scheduled outside the official working days, i.e., Saturday and Sunday, were excluded from the study. In addition, surgeries scheduled on the final operation list for that day or subsequently added to the operation list and cancelled before the patients were taken to the operating room were also not evaluated within the scope of this study. Of the remaining patients, those whose surgeries were cancelled by either the anaesthetist or surgeon after the patient was taken to the operating room and before or after the induction of general anaesthesia were included in Group 1, and those whose surgeries were completed were included in Group 2.

Data Collection

All patients scheduled to undergo surgery were assessed preoperatively by the attending physician based on the type of surgery to be performed and the American Society of Anesthesiologists (ASA) class in the outpatient clinics of the Anaesthesiology and Reanimation Department. The surgeries were scheduled according to the results of the pre-operative assessment.

The follow-up data of the patients subject to surgery cancellation were obtained from the medical files of the patients available in the hospital or queried directly from the patients over the phone.

Patients' demographic characteristics, i.e., age and gender; clinical characteristics, i.e., body mass index (BMI) and ASA class; and surgery details, i.e., the department where the surgery was performed/scheduled to be performed, and the month and the day the surgery was performed/scheduled to be performed were obtained from patients' medical files and preoperative anaesthesiology assessment sheets and recorded. Comorbidities of patients subject to surgery cancellation reasons for cancellation and the clinical course of the patients subject to the cancellation during the 30 days after the cancellation were prospectively obtained and

recorded into a structured worksheet designed for patients whose surgeries were cancelled.[11,12]

The reasons for cancellation were provided by the attending anaesthesiologists or surgeons and categorized as potentially avoidable or unavoidable based on their opinions. The guidelines of the European Society of Hypertension (ESH) and the European Society of Cardiology (ESC) were used to grade arterial hypertension.[13,14] Patients with systolic blood pressures ≥180 mmHg or diastolic blood pressures ≥110 mmHg were considered to have stage 3 or higher hypertension, and their surgeries were cancelled. Potentially avoidable cancellations were those that could have been avoided if adequate preoperative assessment had been made or the hospital personnel had conducted the necessary communications before the scheduled date and time of the surgery. The definitions of potentially avoidable or unavoidable surgery cancellations were included in the structured worksheet for the attending anaesthesiologists or surgeons who are to fill out the worksheet.

Statistical Analysis

The prevalence of elective surgery cancellations after the patient was taken to the operating room was determined as the primary outcome of the study. The study's secondary outcomes included the factors potentially contributing to the elective surgery cancellations such as the department where the surgery was performed/scheduled to be performed and the month and day the surgery was performed/scheduled to be performed. To ensure the integrity and validity of the study findings, statistical analyses were performed using Jamovi project 2.3.28 (Jamovi, version 2.3.28, 2023, retrieved from https://www.jamovi.org) and JASP 0.17.3.0 (Jeffreys' Amazing Statistics Program, version 0.17.3.0, 2023, retrieved from https://jasp-stats.org) software packages, which are recognized for their robust statistical capabilities.

Before conducting any inferential statistical tests, the normal distribution characteristics of continuous variables were rigorously analyzed using the Shapiro-Wilk, Kolmogorov-Smirnov, and Anderson-Darling tests. This step was pivotal in determining the statistical tests for subsequent analyses. The Mann-Whitney U test, known for its non-parametric nature and efficacy in comparing medians, was used to compare variables not conforming to a normal distribution.

Categorical variables, such as the department where the surgery was performed/scheduled to be performed and the month and day the surgery was performed/scheduled to be performed, were analyzed using Pearson's chi-square test, a test used as a standard in medical research for comparing proportions among independent groups. The Fisher-Freeman-Halton test was used in tables with more cells than in a 2x2 table. Probability (*P*) statistics of ≤0.05 were deemed to indicate statistical significance, in line with conventional standards in medical research to minimize Type I errors.

Results

The study sample consisted of 7,482 patients. Of these patients, 67 whose surgeries were cancelled were included in Group 1. Accordingly, the prevalence of cancellations of elective surgeries once the patient was in the operating room was 0.9%. The remaining 7,415 patients were included in Group 2.

The distribution of patients' demographic and clinical characteristics by patient groups is shown in Table 1. Group 1 was significantly older than Group 2 ($P < 0.001$). There was no significant difference between the groups in median BMI values ($P=0.523$). On the other hand, the number of patients categorized as ASA III was significantly higher in Group 1 than in Group 2 ($P < 0.001$). In parallel, the number of patients with the ASA 1 class was significantly higher in Group 2 than in Group 1 (Table 1).

There were also significant differences between the groups in terms of the department where the surgery was performed/scheduled to be performed, and the month and day the surgery was performed/scheduled to be performed ($P < 0.05$) (Table 2). The department with the highest cancellation rate of elective surgeries was ophthalmology (2.5%), followed by general surgery (2.1%), urology (1.5%), and ear, nose, and throat (1.4%) (Figure 1).

The month with the highest cancellation rate of elective surgeries was January (5.3%), followed by February (1.9%)

Table 1. Demographic and Clinical Characteristics of the Patients with and Without Elective Surgery Cancellation

	Group 1 (n = 67)	Group 2 (n = 7,415)	*P* value
Age (year)†	64.0 [20.0-79.0]	51.0 [18.0-102.0]	<0.001*
Sex‡			
Female	29 (43.3)	4121 (55.6)	0.058**
Male	38 (56.7)	3294 (44.4)	
Weight (kg)†	76.0 [52.0-115.0]	75.0 [35.0-168.0]	0.788*
Height (cm)†	170.0 [154.0-180.0]	170.0 [143.0-192.0]	0.221*
BMI (kg m^{2-1})†	26.2 [18.0-44.9]	25.8 [16.3-58.6]	0.523*
ASA status			
1	3 (4.5)[a]	1212 (16.3)[b]	0.001**
2	40 (59.7)[a]	4958 (66.9)[a]	
3	24 (35.8)[a]	1205 (16.3)[b]	
4	0 (0.0)[a]	40 (0.5)[a]	

*: Mann-Whitney U test.
**: Pearson chi-square/Fisher-Freeman-Halton test.
†: Median [min.-max.], ‡: n (%)
[a, b]: Different letters showing significant differences between the groups
Group 1: patients with elective surgery cancellation, Group 2: patients without elective surgery cancellation, ASA: American Society of Anesthesiologists

Table 2. Cancellation Rates of the Groups Based on the Surgical Department, the Scheduled Month and Day			
	Group 1 (n = 67)	**Group 2 (n = 7,415)**	***P* value**
Department			
Ophthalmology (n = 241)	6 (2.5)[a]	235 (97.5)[b]	**<0.001**
General surgery (n = 1,133)	24 (2.1)[a]	1109 (97.9)b	
Urology (n = 1,149)	17 (1.5)[a]	1132 (98.5)[b]	
Ear, nose and throat (n = 516)	7 (1.4)[a]	509 (98.6)[a]	
Plastic and reconstructive surgery (n = 456)	3 (0.7)[a]	453 (99.3)[a]	
Orthopedics (n = 1,287)	7 (0.5)[a]	1280 (99.5)[a]	
Neurosurgery (n = 534)	2 (0.4)[a]	532 (99.6)[a]	
Obstetrics and gynecology (n = 1,845)	1 (0.1)[a]	1844 (99.9)[b]	
Cardiovascular surgery (n = 249)	0 (0)[a]	249 (100)[a]	
Thoracic surgery (n = 72)	0 (0)[a]	72 (100)[a]	
Scheduled month			
January (n = 114)	6 (5.3)[a]	108 (94.7)[b]	**<0.001**
February (n = 530)	10 (1.9)[a]	520 (98.1)[b]	
March (n = 701)	2 (0.3)[a]	699 (99.7)[a]	
April (n = 727)	2 (0.3)[a]	725 (99.7)[a]	
May (n = 582)	3 (0.5)[a]	579 (99.5)[a]	
June (n = 832)	6 (0.7)[a]	826 (99.3)[a]	
July (n = 563)	2 (0.4)[a]	561 (99.6)[a]	
August (n = 699)	5 (0.7)[a]	694 (99.3)[a]	
September (n = 662)	11 (1.7)[a]	651 (98.3)[b]	
October (n = 659)	8 (1.2)[a]	651 (98.8)[a]	
November (n = 711)	6 (0.8)[a]	705 (99.2)[a]	
December (n = 702)	6 (0.9)[a]	696 (99.1)[a]	
Scheduled day			
Monday (n = 1,626)	15 (0.9)[a]	1611 (99.1)[a]	**<0.001**
Tuesday (n = 1,422)	2 (0.1)[a]	1420 (99.9)[b]	
Wednesday (n = 1,499)	6 (0.4)[a]	1493 (99.6)[b]	
Thursday (n = 1,453)	25 (1.7)[a]	1428 (98.3)[b]	
Friday (n = 1,482)	19 (1.3)[a]	1463 (98.7)[a]	

n (%). Fisher-Freeman-Halton test was used.
Group 1: patients with elective surgery cancellation, Group 2: patients without elective surgery cancellation.
[a, b]: Different letters showing significant differences between the groups.

and September (1.7%) (Figure 2). In terms of the days when elective surgeries were cancelled, the cancellation rates of elective surgeries scheduled for Tuesday and Wednesday were lower than those scheduled for other days of the week (Figure 3).

The reasons for elective surgery cancellations are given in Table 3. Stage 3 or 4 hypertension (46.3%) and smoking on the day of the scheduled surgery (26.9%) were the most frequently cited reasons for elective surgery cancellations. Of the causes given for the cancellations of elective surgeries, 59.7% were evaluated as potentially avoidable.

Regarding the clinical course of the patients subject to the cancellation during the 30 days after the cancelation 53 (79.0%) patients underwent surgery after the cancellation of the surgery. Most (98.1%) of these surgeries were performed in the same hospital.

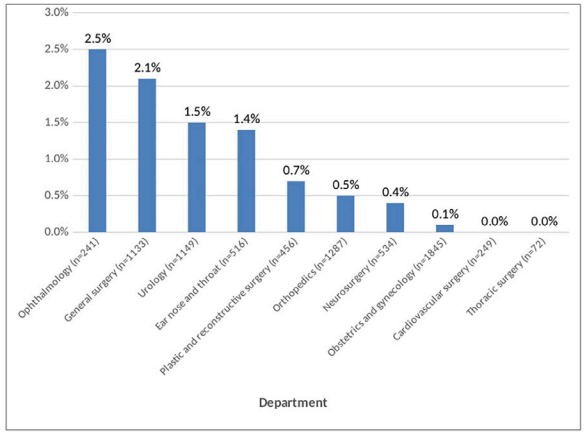

Figure 1. Distribution of the cancellation rates based on the surgical departments.

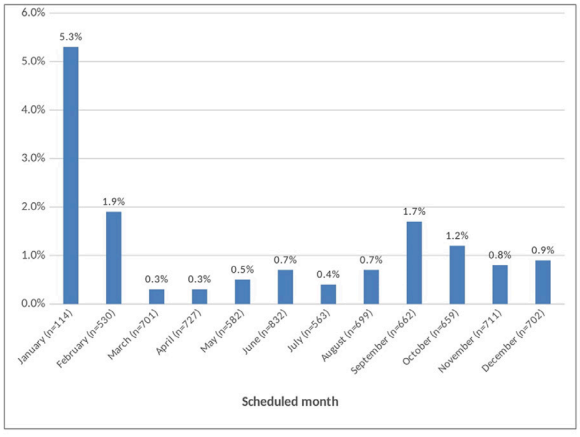

Figure 2. Distribution of the cancellation rates based on the scheduled months.

Discussion

The study findings show that less than one percent of the elective surgeries were cancelled once the patients were taken to the operating room. The elective surgery cancellation rates were found to be higher in the ophthalmology, general surgery, urology, and ear, nose, and throat departments than in the other departments. However, a preliminary analysis of the factors impacting elective surgery cancellations indicated the necessity for a detailed analysis. More than half of the reasons given for elective surgery cancellations were categorized as potentially avoidable factors. Most of these factors were associated with the patients' medical conditions. In this context, increasing the awareness of patients for surgery, improving the communication between patient and physician as well as between patient and hospital administration, and preoperatively assessing patients for elective surgeries are likely to reduce elective surgery cancellation rates.

There are only a few studies in the literature on elective surgery cancellations after patients are taken to the operating room. In two of these studies with seven- and eight-year study periods, surgery cancellation rates after the patients were taken to the operating room were reported as <0.01% and 0.21%, respectively.[11,12] In comparison, in this study, which had a one-year study period, the prevalence of cancellations of elective surgeries once the patient was in the operating room was 0.9%. There were also significant methodological differences between this study and the other two studies. Hori et al.[11] evaluated 30 patients whose surgeries were

Table 3. Reasons for Surgery Cancellation

		Group 1 (n = 67)
Patient-related factors	Smoking	18 (27)
	On anticoagulant medications	3 (4)
	Anxiety	1 (1)
Work up/medical condition		
	Stage 3 or 4 hypertension	31 (46)
	Electrocardiographic changes	6 (9)
	Fever	2 (3)
	Oral herpetic infections	2 (3)
	Uncontrolled thyroid function tests	1 (1)
	Upper respiratory tract infection	1 (1)
Facility-related factors		
	Lack of equipment	1 (1)
	Lack of blood	1 (1)
Avoidable causes for cancellation		40 (59.7)
	Uncontrolled hypertension	31 (46.3)
	Fever	2 (3)
	Anxiety	1 (1.5)
	Upper respiratory infections	1 (1.5)
	Uncontrolled thyroid function tests	1 (1.5)
	Oral herpetic infections	2 (3)
	Lack of equipment	1 (1.5)
	Lack of blood	1 (1.5)
Follow-up		
Received operation at a later time		53 (79.1)
	The same hospital	52 (98.1)
	Others	1 (1.9)

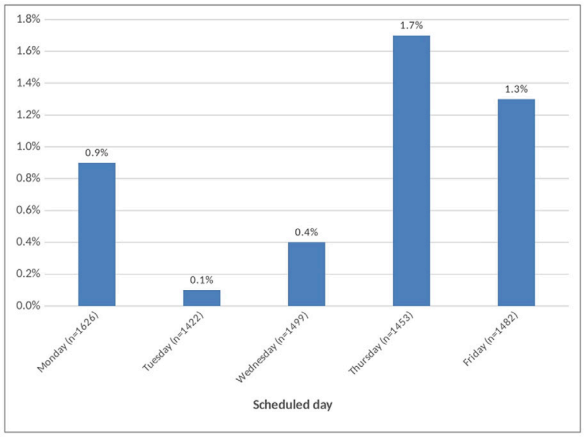

Figure 3. Distribution of the cancellation rates based on the scheduled days.

cancelled after they were taken to the operating room and prepared for general anaesthesia. Eighteen of these patients had their surgeries cancelled before the induction of general anaesthesia and 12 after the induction of general anaesthesia. The primary reasons given for the cancellations after the induction of general anaesthesia were anaphylactic shock (n = 3) and arrhythmias (n = 4). In the study by Perroca et al.[15], surgery cancellations were stratified according to whether they occurred before the preparation and arrangement of the operating room or after the operating room was prepared and anaesthetic-surgical procedures were started. In comparison, in this study, surgery cancellations were not stratified as such.

Hori et al.[11] and Chang et al.[12] reported surgery cancellation rates after the induction of general anaesthesia as 40% and 12.7%, respectively. In comparison, in this study, none of the 67 surgery cancellations were made after the induction of general anaesthesia. Surgery cancellations after initiating general anaesthesia are rare and are primarily due to unexpected and unpredicted changes in the patient's clinical condition.[11,12,15]

Fitzsimons et al.[16] investigated 43 cardiac surgery cancellations made after the patients were taken to the operating room and before the initiation of surgical incisions. These 43 surgery cancellations constituted 0.84% of all surgeries conducted during the four-year study period. Similar surgery cancellation rates have been reported in other studies.[17,18] The findings of these studies have not been compared with those of the studies that specifically addressed cardiac surgery cancellations due to technical differences specific to heart surgeries.

Stratifying the reasons for surgery cancellations as potentially avoidable or unavoidable may not be a precise method.[3,7,12] In fact, Hori et al.[11] categorized 36.7% of the reasons given for surgery cancellations before the induction of general anaesthesia as potentially avoidable, stating that they could have been prevented by improving the pre-operative assessment of the patients in terms of their medical problems, 59.7% of the reasons given for surgery cancellations before the induction of general anaesthesia in this study were categorized as potentially avoidable. In different studies, the rate of potentially avoidable reasons among the reasons given for elective surgery cancellations before the induction of general anaesthesia has been estimated to be between 60% and 70%.[3,7,15] It is not an easy task to compare these studies because of the heterogeneities in patient groups and methodologies. However, detailed preoperative assessment of patients is the most effective measure to prevent surgery cancellations.[11]

Previous studies grouped the causes of surgery cancellations as patient-related, facility-related, and surgery-related.[2-5,7,19,20] The characteristics of patients, hospital facilities, medical and administrative staff, and the socioeconomic status of patient populations have been cited as the primary components of patient-related, facility-related, and surgery-related causes resulting in surgery cancellations.[21] We did not use such stratifications due to the narrower focus of the study, which addressed only the cancellations made once the patient was taken to the operating room. Becker et al.[22] investigated the non-medical risk factors that lead to postponing elective surgeries. They found that advanced age, retirement, and nursing home residence were risk factors for surgery cancellation and rescheduling. Along these lines, in this study, the patients whose surgeries were cancelled were significantly older, and a higher number of patients whose surgeries were cancelled were categorized as ASA III compared with the patients whose surgeries were completed as scheduled. Although the patients whose surgeries were cancelled were significantly older than those whose surgeries were completed as scheduled, the fact that their median age was below 65 may be a confounding factor. We did not separately investigate the impact of each demographic and clinical characteristic on cancellation rates. Nevertheless, we found that the reasons for surgery cancellations were mainly related to the patients' medical conditions and may thus be considered patient-related reasons.

According to the current study, smoking and uncontrolled hypertension were the most frequent causes of cancellations for all elective surgeries. The management of hypertension during the perioperative period has become increasingly crucial considering the growing number of surgeries performed worldwide and the large number of hypertensive patients.[23] In addition, preoperative hypertension raises perioperative risks, which may cause anaesthesiologists to hesitate during the induction of anaesthesia.[24] The decision to proceed with surgery in patients with uncontrolled hypertension before induction of anaesthesia has been a

medical dilemma for many years.[25,26] Guidelines from the ESC and the ESH state that if blood pressure is 180 mmHg systolic and 110 mmHg diastolic, elective surgery should not be cancelled.[23] In a prospective comparative study, Soni et al.[27] found that inappropriate cancellations due to hypertension decreased significantly over the years (from 1.37% to 0.05%) in keeping with the recommendations in the guidelines. In accordance with recently released guidelines, all cancellations in this study involving uncontrolled hypertension occurred in patients with stages 3 and 4. A comparable number of patients were assessed in this study and the one by Soni et al.[27]. On the other hand, cancellation rates due to uncontrolled hypertension may have been higher in our center because cancellation times were different between the two studies. This difference can be explained by patients' non-compliance with treatment regimens, disruption of periodic check-ups, and sociocultural context.

Preoperative smoking is associated with impaired wound healing and many serious complications involving the pulmonary, cardiovascular, and neurological systems.[28,29] It is most likely the result of cumulative chronic and acute toxic effects from inhalation. Consequently, if a patient smokes before an elective procedure, anaesthesiologists may cancel the procedure. In this study, the reason for most of the cancelled cases was smoking. Based on evidence from randomized controlled trials, guidelines recommend smoking cessation for at least 4 weeks before elective surgeries.[30] This may not be possible in the daily routine. Although preoperative smoking is considered a preventable cause with education about its potential harms in the perioperative period, smoking may not be prevented because it is related to the patient's sociocultural and addiction status. Patients may smoke covertly prior to surgery, and some may even admit smoking before the induction of anaesthesia.

The study's prospective design was its primary strength because it allowed a more accurate data collection process. This study did not address cancellations made before the patients were taken to the operating room. Thus, the study's single-center design, along with the fact that only the cancellations made after the patients were taken to the operating room were taken into consideration, may limit the generalizability of this study's findings to other settings. In addition, the significance level of the statistical analyses conducted according to the department where the surgery was performed/scheduled to be performed, and the month and the day the surgery was performed/scheduled to be performed may be questioned due to the smaller sizes of each subgroup. Lastly, we had difficulty explaining the unexpectedly higher surgery cancellation rates observed in January, which is likely associated with administrative issues.

Conclusion

The prevalence of elective surgery cancellations after the patients were taken to the operating room was less than one percent (0.9%). Most surgery cancellations were related to patients' medical conditions and lack of surgical awareness. More than half of the reasons given for surgery cancellations were categorized as potentially avoidable. Therefore, improving the surgical awareness of patients, establishing effective communication with patients, and preoperatively assessing patients for elective surgical procedures are likely to reduce elective surgery cancellation rates after the patients are taken to the operating room.

Ethics

Ethics Committee Approval: The study protocol was approved by the Süleyman Demirel University Faculty of Medicine, Ethical Committee for Clinical Studies before the study (approval no: 3/33, date: 26.01.2022).

Informed Consent: Written informed consent was obtained from all patients.

Author Contributions: Concept - M.S., F.A.S.; Design - M.S., F.A.S.; Data Collection or Processing - M.S., E.S., A.K.; Analysis or Interpretation - M.S., E.S., F.A.S., A.K.; Literature Search - M.S., Y.A., P.K.; Writing - M.S., Y.A., P.K.

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Original Article

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Effects of Pulsatile and Non-Pulsatile Cardiopulmonary Bypass Techniques in Coronary Artery Bypass Grafting Surgeries on Cerebral Perfusion

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Abstract

Objective: We aimed to evaluate the effects of cardiopulmonary bypass (CPB) machines used in coronary artery bypass grafting surgeries on cerebral perfusion by performing cerebral oximetry monitoring [near-infrared spectroscopy (NIRS)], S100-β protein measurements, and neurocognitive function assessment tests using both pulsatile and non-pulsatile modes.

Methods: A total of 44 patients, 22 non-pulsatile (Group NP) and 22 pulsatile (Group P), were included in the study. Hemodynamic parameters, arterial blood gas values, NIRS values and blood S100β protein levels were analyzed at five points: pre-induction (T1), initiation of CPB (T2), termination of CPB (T3), end of surgery (T4), and postoperative 24 h (T5). Two different neuropsychological tests were administered to patients in the preoperative and postoperative periods.

Results: There were no significant differences between the groups for demographic characteristics such as age, gender, body mass index, aortic cross-clamping, CPB, and operation durations. The mean arterial blood pressure and PaO_2 values for the T2 measurements were significantly higher in group NP ($P < 0.05$). Regional cerebral oxygen saturation (rSO_2) (NIRS) values at T3 and T4 were significantly higher in group P ($P < 0.05$). Serum S100β measurement values at T3 and T5 were significantly higher in group NP than in group P ($P < 0.05$). Serum S100β protein levels at T3 correlate with rSO_2 results. There was no statistically significant difference between the two groups in terms of pH, lactate, glucose, partial pressure of carbon dioxide, and peripheral oxygen saturation values.

Conclusion: Despite no difference between the two groups for neurocognitive function tests, we believe that pulsatile perfusion may be more beneficial for cerebral perfusion when S100β protein and NIRS values are considered. Further clinical studies are needed to evaluate the benefits of the pulsatile technique for cerebral perfusion.

Keywords: Cardiopulmonary bypass, cardiovascular and thoracic anaesthesia, near-infrared spectroscopy, postoperative cognitive disfunction, pulsatile flow, S100β protein

Main Points

- The effects of the pulsatile technique and non-pulsatile technique using the cardiopulmonary bypass (CPB) machine were compared for postoperative cerebral functions. Pulsatile pump flow was found to be more beneficial according to regional cerebral oxygen saturation (rSO_2) and S100β protein results.
- The rSO_2 recorded in the T3 and T4 periods were significantly higher in group P than in group NP, representing better cerebral perfusion with pulsatile CPB flow.
- S100β values were lower at T3 and T5 time intervals with pulsatile perfusion.
- According to the results of neurocognitive tests, no significant difference was found between the groups in terms of postoperative cognitive dysfunction.

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Introduction

In the mid-20th century, the cardiopulmonary bypass (CPB) machine developed by John Gibbon enabled surgery to be performed for many cardiac malformations, such as coronary artery disease, valve repair, and replacement. However, it also has some negative effects on the organs it perfuses. The brain, which is highly sensitive to hypoxia, may be affected by thromboembolic ischemic events, bleeding, or inflammatory responses secondary to the procedures that occur during CPB.[1]

After cardiac surgery, major neurological complications (intracranial hemorrhage, ischemic stroke, etc.), neurocognitive dysfunction, and subclinical neurological deficits can be observed. In addition, cognitive function disorders such as memory loss, concentration impairment, and loss of fine motor skills that develop after the use of CPB have also been reported. However, there is still no consensus regarding the incidence, etiological causes, diagnostic methods, and course of these complications.[2]

Imaging methods involve some clinical difficulties with their use for diagnostic purposes after the development of complications and lack of bedside use. Near-infrared spectroscopy (NIRS) is a technology that interprets oxy- and deoxyhemoglobin signals to measure regional cerebral oxygen saturation (rSO_2) in real time. NIRS is a non-invasive, easy-to-use, and inexpensive method that has proven feasibility and safety during cardiac surgery. It has all the theoretical advantages that make it the gold standard for real-time cerebral monitoring in cardiac surgery, as it measures cerebral oxygenation independently of brain function, metabolism, and cerebral blood flow.[3]

No universally accepted definition of postoperative cognitive decline, or dysfunction (POCD) has been developed, and its pathogenesis remains unknown. The statistical criteria and methods used to define POCD, the selection and evaluation of neuropsychological tests, and the evaluation time of assessment are primarily left to the discretion of the authors, resulting in a wide variation of POCD incidence in different studies.[4,5]

Currently, there is interest in using biochemical markers because of the insufficient sensitivity of neuropsychological tests for the diagnosis of neurological disorders[6] that develop after cardiac surgery. S100β and neuron-specific enolase (NSE) proteins, which are specific proteins originating from neurons, can be used as neurobiochemical markers because they are linked to stroke, traumatic brain injury, cardiac arrest, and brain damage after CPB.[7]

Our aim was to investigate the effects of non-pulsatile and pulsatile CPB pumps on cerebral circulation by measuring S100β protein and monitoring NIRS. In addition to these measurements, we aimed to observe whether there was a deterioration in postoperative basic neurocognitive functions by comparing preoperative and postoperative mini-mental test scores.

Methods

After obtaining approval from the University of Health Sciences Turkey, Bakırköy Dr. Sadi Konuk Training and Research Hospital, Clinical Research Ethics Committee with protocol code 2012/15/08 and date 05.11.2012, coronary artery bypass grafting surgery was planned under elective conditions. A total of 44 patients who were over the age of 18 and under the age of 70, with ejection fraction more than 40%, and who had adequate educational attainment to perform neurocognitive testing were included, while patients with severe cardiac insufficiency and carotid stenosis, a previous history of cardiovascular accident, and renal failure were excluded.

The patients were verbally and in writing informed, and written informed consent forms were obtained.

The patients were randomized into two groups. Group P (n=22) received pulsatile CPB, and Group NP (n=22) received non-pulsatile CPB.

Transient POCD and postoperative delirium (POD) are relatively common complications after surgery. Patients undergoing cardiac surgery are at high risk of both conditions, but the predisposing cognitive profile for these conditions has not yet been fully elucidated.[8]

According to The American Psychiatric Association's fifth edition of the Diagnostic and Statistical Manual of Mental Disorders, delirium is defined as a condition with the following five key features: disturbance in attention and awareness; the disturbance develops over a short period of time and its severity tends to fluctuate during a day; an additional disturbance in cognition; these mentioned disturbances cannot be better explained by other pre-existing neurocognitive disorders and do not occur in severely reduced arousal level such as coma; and there is evidence suggesting the disturbance is a direct result of another medical condition.[9]

Mini-Mental State Examination (MMSE) is the most widely recognized and used brief screening instrument for detecting cognitive deficits. Both the MMSE and the Montreal Cognitive Assessment (MoCA) are brief cognitive screening tools that are administered in a paper-and-pencil format. For both tests, a score is derived by summing the points from each successfully completed task, for a total range of 0-30 points; higher scores indicate better cognitive performance. MoCA was developed to screen milder forms of cognitive impairment through the assessment of a wide range of cognitive functions, such as short-term memory, executive functions, visuospatial abilities, language,

attention, concentration, working memory, and temporal and spatial orientation by Nasreddine et al.[11] in 2005.[10]

The standardized MMSE (SMMSE) and the MoCA were administered preoperatively one day before surgery and postoperatively on the 7th day to evaluate the neurocognitive functions of the patients. Reliability and validity studies for the Turkish form of MMSE were conducted by Güngen et al.[12] in 2002.

At the beginning of the operation, all patients were monitored with electrocardiogram (ECG), non-invasive blood pressure, peripheral oxygen saturation (SPO_2), NIRS, and bispectral index (BIS) for depth of anaesthesia. Subsequently, invasive blood pressure monitoring was performed. During induction, 0.1-0.2 mg kg^{-1} of midazolam, 5-8 µg kg^{-1} of fentanyl, and 0.6 mg kg^{-1} of rocuronium were administered to the patients. The aim was to maintain the depth of anaesthesia in the range of 40-60, which is the BIS general anaesthesia level for sevoflurane inhalation and remifentanil infusion.

The pump priming fluid was prepared with 1000 cc Isolate S, 100 cc 20% mannitol, and 100 mg heparin. CPB was initiated by aortoatrial cannulation in all cases. The CPB circuit included a roller pump (Stöckert SV, C5), 40 µm arterial filter, adult membrane oxygenator, and hard-shell venous cardiotomy reservoir. The pump flow was adjusted to set the mean arterial blood pressure (MAP) at 50-70 mmHg during CPB. The nasopharyngeal body temperature was lowered to 32 °C. Following the placement of an aortic cross-clamping (ACC), non-pulsatile perfusion was applied to the first group and pulsatile perfusion was applied to the second group. The pump module was used to run pulsatile pump flow control with an internal ECG simulator during total bypass. The flow characteristics were determined by selecting the pump usage percentage and continuous basal flow for each ECG cycle. The heart rate was set to 60-70 rpm in the pulsatile mode. The pulse width was adjusted to 40-50% and the basal flow amount was set to 35-50%.

The demographic characteristics of the patients [age, gender, and body mass index (BMI)], and the durations of the operation, ACC, and CPB were recorded. The levels of MAP, SPO_2, right and left rSO_2, partial pressures of oxygen and carbon dioxide (PaO_2, $PaCO_2$), pH, lactate, glucose and S100β protein were evaluated and recorded before the induction of anaesthesia (T1), at the beginning of CP, after 5 min of ACC (T2), at the termination of CPB after ACC remova, before weaning (T3), at the end of the operation (T4), and in the postoperative 24th hour (T5) (Table 1).

Human S100β was tested using the Bio Vendor (Czech Republic) ELISA method. The standards, quality control serum, and patient samples were pipetted onto polyclonal antibody-coated microplates with the catalog number RD192090100R. After 120 min of incubation, the washing procedure and number of washes were performed as suggested in the kit protocol, followed by the addition of biotin-labeled monoclonal anti-human S100β antibody. A second incubation of 60 min was performed, and the washing procedure was repeated. After the conjugate and substrate pipetting procedure was completed, the reaction was stopped and a reading was obtained at 450 nm. Logarithmic graphs were drawn for absorbances and converted to pg mL^{-1} for concentration. The intra-assay coefficient of variation (CV) values for the kit were reported as 3.8%, and the inter-assay CV values were 5.2%.

Before the study, a preliminary study of 5 cases was conducted using Group NP and Group P. The mean and standard deviation values for S100β protein levels measured in the T5 period for Group NP and Group P were calculated as 60±50 pg mL^{-1} and 30±20 pg mL^{-1}, respectively. In the power analysis made according to these values, the number of patients to be included in each group was calculated as 21, a total of 42, in order for the power of the study to reach 80% with a margin of error of α=0.05 (GPower 3.1).

Statistical Analysis

The data homogeneity of the groups was evaluated using the Shapiro-Wilk test. Student's t-test was used for paired group comparisons. For statistical representation, the mean and standard deviation were used. Values with $P < 0.05$ were considered statistically significant. The statistical analysis in this study used the SPSS V22 statistical program. As the primary outcome of the study, S100β levels measured in the postoperative 24th hour (T5) were determined for both groups.

Results

There were no significant differences between the groups for demographic characteristics such as age, gender, BMI, ACC, CPB, and operation durations (Table 1).

Before anaesthesia induction (T1), at CPB initiation (T2), end of CPB (T3), end of the operation (T4), and at postoperative 24th hour (T5), there were no significant differences between MAP, SPO_2, blood pH, pO_2, partial pressure of carbon dioxide, lactate level, and glucose level (Table 2).

Comparison of rSO_2 right and rSO_2 left values showed that rSO_2 right and rSO_2 left values were significantly higher in Group P than in Group NP at termination of CPB (T3) and end of operation (T4) ($P < 0.05$). No statistically significant difference was found between the groups in terms of the averages for the other levels ($P > 0.05$) (Table 3).

When comparing the average levels of S100β protein between the groups, the levels of S100β protein in Group NP at termination of CPB (T3) and 24 h after the operation (T5) were significantly higher than those in Group P ($P < 0.05$). No statistically significant difference was found between the groups in terms of S100β protein levels recorded at other time intervals ($P > 0.05$) (Table 4).

Table 1. Comparison of Characteristics Between Groups

	Group NP (Mean ± SD)	Group P (Mean ± SD)	*P* value
Age	57.7±8.5	57.7±7.3	0.985
BMI	29.2±2.8	30±4.2	0.18
ACC duration	38.7±13.3	42.4±7.0	0.259
CPB duration	72.7±20.9	80.1±11.8	0.155
Operation duration	213.3±56.1	213.9±16.5	0.961

BMI, body mass index; ACC, aortic cross-clemping; CPB, cardiopulmonary bypass; SD, standard deviation.

Table 2. Comparison of Characteristics Between Groups

		Group NP (Mean ± SD)	Group P (Mean ± SD)	*P* value
MAP				
	T1	84.8±21.9	77.7±15.9	0.225
	T2	64.9±10.7	56.3±9.2	0.006*
	T3	60.4±13	62.7±10	0.504
	T4	84.8±9.6	82.1±9.8	0.348
	T5	84.8±9.6	82.1±9.8	0.348
SpO_2				
	T1	98.3±2.4	99.3±1	0.067
	T2	99.2±1.1	98.7±1.6	0.254
	T3	98.9±1.5	98.2±1.9	0.238
	T4	97.2±1.5	97.1±1	0.635
	T5	97.2±1.5	97.1±1	0.635
PaO_2				
	T1	213.6±70.1	220.8±68.3	0.734
	T2	228.1±66	165.9±52.5	0.001*
	T3	199.4±68.3	191.6±68.4	0.708
	T4	153.4±38.1	152.2±25.7	0.905
	T5	153.4±38.1	152.2±25.7	0.905
$PaCO_2$				
	T1	37.4±4.4	36.7±8.2	0.750
	T2	38.1±6.3	38±6.1	0.942
	T3	35.3±4.6	37.4±6.4	0.231
	T4	38.3±5.1	39.4±5.7	0.510
	T5	38.3±5.1	39.4±5.7	0.510
pH				
	T1	7.41±0.04	7.41±0.03	0.867
	T2	7.39±0.05	7.4±0.05	0.879
	T3	7.40±0.05	7.38±0.05	0.374
	T4	7.38±0.05	7.36±0.05	0.255
	T5	7.41±0.05	7.41±0.04	0.718

Table 2. Continued

		Group NP (Mean ± SD)	Group P (Mean ± SD)	*P* value
Lactate				
	T1	0.69±0.38	0.90±0.29	0.057
	T2	0.87±0.35	1.02±0.39	0.168
	T3	1.35±0.48	1.23±0.43	0.396
	T4	1.52±0.61	1.37±0.53	0.369
	T5	1.57±0.65	1.70±0.82	0.572
Glucose				
	T1	127.3±40.1	126.2±35.7	0.918
	T2	136.9±29.6	138.6±34.5	0.867
	T3	176.6±42.2	169.7±43	0.599
	T4	168.1±41.3	162.2±33.1	0.606
	T5	162.1±31.5	175.9±41.8	0.220

**P* value is statistically significant.
MAP, mean arterial pressure; PaO_2, partial oxygen pressue; $PaCO_2$, partial carbon dioxide pressure; SD, standard deviation.

Table 3. Comparison of rSO_2 Right and rSO_2 Left Values Between Groups

		Group NP (Mean ± SD)	Group P (Mean ± SD)	*P* value
RSO_2 right				
	T1	65.1±6.4	63.4±10.3	0.518
	T2	58.9±10.2	57.9±9.4	0.760
	T3	53.9±12.2	61.3±8.8	**0.027***
	T4	57.4±11.3	63.5±7.3	**0.047***
RSO_2 left				
	T1	63.8±6.3	64.2±8.3	0.871
	T2	56.7±10.1	57.8±9.5	0.725
	T3	53.9±11.1	60.9±9.1	**0.029***
	T4	57±10.4	63.6±7.7	**0.042***

**P* value is statistically significant.
RSO_2, regional oxygen saturation; SD, standard deviation.

Table 4. Comparison of S100β Protein Levels Between Groups

S100β		Group NP (Mean ± SD)	Group P (Mean ± SD)	*P* value
	T1	47.35±83.9	19.3±10.6	0.127
	T2	121.6±108.3	68.5±79.7	0.071
	T3	391.9±275.8	212.9±244.9	**0.028***
	T4	358.7±311.1	205.4±183.6	0.053
	T5	71.3±48.8	26.2±10.6	**0.001***

**P* value is statistically significant.
SD, standard deviation.

Table 5. Comparison of Montreal Test and SMMT Between Groups

		Group NP (Mean ± SD)	Group P (Mean ± SD)	*P* value
Montreal test				
	Preop.	21.5±3.5	21.7±5.2	0.894
	Postop.	19.9±4.5	21±5	0.451
SMMT				
	Preop.	25.7±2.8	24.2±3.6	0.121
	Postop.	24.4±2.9	23.4±3.6	0.340

SMMT, Standardized Mini-Mental Test, SD, standard deviation; Preop., preoperative; Postop., postoperative.

No statistically significant differences were found between the pre- and post-operative averages for the SMMSE and MoCA between the groups ($P > 0.05$) (Table 5).

Discussion

Cardiac surgery differs from other types of surgeries because of the potential for different complications related to the CPB machine. Contact of blood with synthetic surfaces in CPB equipment causes vasospasm, platelet-endothelial cell interactions, and increased inflammatory response, which may result in decreased microcirculation of the heart, brain, and other organs that can cause dysfunction of these organs.[13] Current research targets the reduction of these negative effects and prevention of potential complications of CPB and its components, while discussions and studies about the perfusion method continue.[14]

In this study, we compared the effects of the pulsatile technique with the CPB machine on postoperative cerebral functions. Although significant differences were found for rSO_2 and S100β protein results in the perioperative period with the use of the pulsatile perfusion technique, which is relevant to our hypothesis that pulsatile CPB flow may be more beneficial for cerebral perfusion, the two techniques were similar in terms of postoperative cognitive function. In contrast to the pulsatile flow present in normal circulation, CPB has been developed with a non-physiological laminar flow profile. This pulsatile flow is a necessary factor for sustaining adequate microcirculation and providing oxygen and nourishment to the internal organs.

However, because CPB is traditionally used with the non-pulsatile technique, this non-physiological blood flow may have adverse effects on microcirculatory perfusion. The pulsatile perfusion technique has not been adopted as a routine technique because the idea that pulsatile flow may provide extra benefits during CPB contradicts the idea that pulsatility can damage blood cells. In a systematic review of post-CPB microcirculatory disturbances, the microvascular flow index decreased during CPB, which may lead to a microcirculatory disorder.[15] In this compilation, three studies compared pulsatile blood flow during CPB with non-pulsatile blood flow.[16-18] Koning et al.[17,18] reported that microcirculatory perfusion was protected following weaning from CPB with pulsatile blood flow compared with non-pulsatile flow using sidestream dark field imaging to evaluate sublingual mucosal microvascular perfusion, while O'Neil et al.'s[16] study reported that microcirculatory perfusion was preserved with pulsatile flow compared with non-pulsatile flow during CPB. In a study by Zhao et al.[19] of 40 infants with Fallot tetralogy, microcirculation improvement was described as an advantage of pulsatile flow; however, they also noted that pulsatile pumps could have the potential disadvantages of higher levels of hemolysis and potential platelet activation. Despite the extensive literature and increasing number of studies, the question of whether pulsatile perfusion flow is superior to non-pulsatile flow during CPB remains unanswered.[20,21] Considering that pulsatile flow may be beneficial in cardiac surgery despite the different focuses and results in the literature, we aimed to observe its possible beneficial effects on cerebral circulation.

Many studies have summarized the benefits of NIRS in preventing potential catastrophic neurological events that cannot be detected using conventional monitoring. Cardiac surgery patients with significant decreases in rSO_2 from baseline values are at increased risk of POCD, delirium, and longer intensive care unit and hospital stays.[22]

According to a study on POCD, patients with POCD had lower perioperative cerebral rSO_2 than those without POCD. The decrease in rSO_2 played an important role in the development of POCD, offering an appropriate monitoring method and potential treatment target.[23]

Therefore, in this study, cerebral oxygen saturation was monitored using NIRS. The rSO_2 values recorded at T3 and T4 periods were found to be significantly higher in group P, representing better cerebral perfusion with pulsatile CPB flow, whereas the neuropsychological test results of our study did not correlate with cerebral rSO_2 values.

Due to advances in medical techniques, the rates of major complications (e.g., mortality) following cardiac surgery have decreased, whereas the incidence of POCD has remained unchanged and it has become the most common postoperative complication.[24] A recently formed multinational, multidisciplinary, and multispeciality expert group (Perioperative Cognition Nomenclature Consensus Working Group) recommended that cognitive impairment identified in the perioperative period be called "perioperative neurocognitive disorders" (PND). In addition, no universal neuropsychological testing method has yet been proposed by the group, and cognitive domains

(such as memory, attention, visual-spatial organization, verbal fluency, motor function, and processing speed) considered for testing have not been defined.[25,26] Currently, multiple tests are advocated for the diagnosis of PND. Therefore, in the present study, the SMMSE, which is the most widely recognized and used brief screening instrument for detecting cognitive deficits, and the MoCA, which is a brief instrument developed for the screening of milder forms of cognitive impairment, having surpassed the well-known limitations of the MMSE,[10] were applied to patients one day before the operation and on the seventh postoperative day to identify cognitive disorders that may occur after cardiac surgery. The incidence of POCD varies widely in different studies because the statistical criteria and methods used to define POCD, neuropsychological test selection, and evaluation duration are left to the discretion of clinicians.[27] According to the results of the neurocognitive tests conducted in our study, no significant difference was found between the groups in terms of POCD.

Despite the efforts made and the progress in surgical techniques during the past decades, the incidence of delirium after cardiac surgery remains between 26% and 52% when estimated with rigorous methodology.[28] POD and POCD are common complications of cardiac surgery. It is unknown whether they have a similar etiology and pathophysiology. The relationship between POD and POCD is complex and not yet fully elucidated. Both entities share many risk factors, such as increasing age, low level of education, and underlying comorbidities, and might be viewed as two expressions of the same underlying process of pre-existing decreased cognitive reserve, as opposed to other evidence supporting a more independent, possibly causal relationship between delirium and cognitive impairment. A causal relationship could have important clinical implications because delirium would then be one of the few modifiable risk factors for POCD, opening up possibilities for prevention. The magnitude of the influence of delirium as an independent risk factor for POCD is difficult to determine.[8]

S100β protein can be found in glial and Schwann cells but cannot be detected in serum except in patients with significant medical pathologies. According to an article that investigated neurocognitive function and biochemical markers after cardiac surgery, medical conditions such as paralysis, subarachnoid hemorrhage, head trauma, CPB, and coma after cardiac arrest can lead to an increase in serum S100β protein.[29]

In an article investigating delirium after cardiac surgery, the ideal delirium indicator should have high sensitivity and specificity, be associated with the severity of the disease, be stable, easily accessible, independent of physiological variables, cost efficient, easily identifiable, and have high validity, as well as be associated with a known mechanism such as localized damage.[30] However, developing an ideal marker for delirium or POCD is a complex process because there are many intricate factors that contribute to the occurrence of PND.

According to a study on cognitive dysfunction after CABG surgery, additional evidence suggested that CABG surgery with CPB was associated with high postoperative serum S100β protein and NSE levels, which can indicate significant neural damage, and that S100β protein serum levels may be more accurate than NSE in predicting POCD. They also reported that using a test panel instead of a single biomarker may provide more benefit for the early diagnosis of delirium after cardiac surgery.[7]

Fazio et al.[31] showed that the elevation of S100β during and after cardiothoracic surgery is associated with perioperative factors such as the presence of extracorporeal pumps, use of cell savers, and degree of perfusion, in addition to patient-related factors such as age, gender, and the presence of hypertension. In the present study, the analysis of S100β protein used serum biomarkers and pulsatile perfusion flow was more advantageous based on S100β protein values at times T3 and T5 (Table 5), which may represent significant neural damage during non-pulsatile CPB flow. Despite many studies analyzing serum S100β levels to evaluate neurological dysfunction that may arise because of the surgical procedure in patients who have undergone cardiac surgery, the relationship between S100β levels and neurological and neurophysiological findings has not been fully defined.[29]

However, no biomarker has been found with sufficient sensitivity and specificity to be the gold standard determinant of neurological dysfunction after cardiac surgery. In clinical studies conducted in a similar manner, no single method was sufficient for the diagnosis of POCD. Therefore, in the present study, while investigating the cerebral effects of pulsatile perfusion during CPB, biochemical biomarkers, rSO_2, and neuropsychological tests were applied, and the correlation between these methods was evaluated. As a result, rSO_2 values were higher at T3 and T4 time intervals with pulsatile perfusion, while S100β values were lower at T3 and T5 time intervals, which may indicate better cerebral perfusion.

Study Limitations

Our study has a few limitations. First, the lack of correlation between neurological monitoring and neuron-specific biomarker results and neurocognitive tests may have been due to the small number of cases. Second, the results may not reflect the general population because the study was

conducted in a single center with a limited number of patients.

Conclusion

In conclusion, while potential beneficial effects of pulsatile perfusion with the CPB machine on neurocognitive functions were observed, there is no gold standard test to diagnose potential neurologic disorders. We believe that follow-up, treatment, and diagnosis protocols should be established, including the perfusion technique, to identify and prevent any cerebral perfusion disorders that may occur during and after CPB. Therefore, we believe that larger-scale studies will be beneficial and provide results that are consistent with clinical data that may lead to routine use of pulsatile CPB flow.

Ethics

Ethics Committee Approval: Ethical approval was obtained from the University of Health Sciences Turkey, Bakırköy Dr. Sadi Konuk Training and Research Hospital, Clinical Research Ethics Committee with protocol code 2012/15/08 and date 05.11.2012.

Informed Consent: The patients were verbally and in writing informed, and written informed consent forms were obtained.

Author Contributions: Concept - İ.B., B.G.; Design - İ.B., B.G.; Supervision - Z.Ç.; Data Collection or Processing - E.K.T.; Analysis or Interpretation - İ.P.; Literature Search - İ.P.; Writing - İ.P.; Critical Review - G.D.

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Use of an Endobronchial Blocker in a Patient with Tracheobronchial Anomaly for Minimally Invasive Cardiac Surgery: A Case Report

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Abstract

Tracheal bronchi (TB) is a rare anomaly and is usually asymptomatic. Although it is generally not a problem when a single lumen tube is used, it may cause ventilation difficulties in the intraoperative period in procedures requiring one lung ventilation, such as minimally invasive cardiac surgery. Therefore, these difficulties may cause intraoperative and postoperative complications. While a double-lumen tube is recommended as the primary choice for one-lung ventilation in patients with TB, bronchial blockers can be used to avoid the need for tube exchange in patients who will remain intubated in the postoperative period.

Keywords: Endobronchial blocker, minimally invasive cardiac surgery, one lung ventilation, tracheal bronchus, tracheobronchial anomaly

Main Points

- The frequency of minimally invasive cardiac surgery has increased in recent years and requires one lung ventilation.
- Tracheal bronchi are often incidentally diagnosed, posing challenges to endotracheal intubation and lung isolation, particularly during procedures requiring lung isolation.
- By diagnosing the tracheal bronchus in the pre-operative period, safe one-lung ventilation can be provided and possible postoperative pulmonary complications can be prevented.

Introduction

Minimally invasive cardiac surgery (MICS) has become increasingly prevalent due to its advantages such as high patient satisfaction, favorable cosmetic outcomes, reduced postoperative pain, diminished stress response, decreased transfusion requirements, and accelerated recovery with a quicker return to normal activities.[1,2] However, there are also disadvantages to this approach. Even in MICS patients with normal respiratory functions, postoperative atelectasis, pulmonary edema, and ventilation-perfusion mismatch can occur because of one-lung ventilation.[3]

The tracheal bronchus (TB) is a congenital anomaly defined as an abnormal bronchus originating from anywhere between the cricoid cartilage and the carina and directed toward the upper lobe of the lung. Although it can arise anywhere between the cricoid cartilage and the carina, it typically appears approximately 2 cm proximal to the carina.[4] The prevalence of TB, usually on the right side, is a topic of debate. Various studies employing bronchoscopic, bronchographic, and computed tomography (CT) examinations have reported the presence of TB in approximately 0.1-1.3% of adults and 1.5-2% of the pediatric population. Although it rarely leads to recurrent

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infections in adults, it is often incidentally diagnosed on CT scans. In children, the presence of TB may manifest with symptoms such as recurrent pneumonia, stridor, or respiratory distress.[5]

Several classifications exist for the tracheal bronchi, but the most relevant for anesthesiologists is Conacher's classification based on the anatomical relationship between the TB and the carina.[6] Conacher identified three types based on this relationship:[7] Type I, where the TB is ≥2 cm from the carina and the distal trachea is narrowed; Type II, where the TB is ≥2 cm from the carina and the distal trachea has a normal diameter; and Type III, where the TB is at or near the level of the carina.

Although tracheal bronchi are often clinically asymptomatic, they may present symptoms when OLV is required. Complications such as atelectasis, hypoxemia, and barotrauma can arise when TB is occluded.[6,8] In some cases, it can lead to inadequate lung isolation.[6,9]

This case report aims to share the use of endobronchial blockers (EBB) in a patient with tracheal bronchial anomaly, highlighting the importance of addressing such anomalies in MICS.

Case Presentation

A patient undergoing minimally invasive coronary artery bypass grafting (CABG) through informed and consented left thoracotomy was evaluated for perioperative findings. The patient, a 53-year-old man with an ASA physical status of II, weighing 73 kg and measuring 172 cm, had a history of smoking and diabetes as the only comorbidity. Standard ASA monitoring was initiated. The following induction, endotracheal intubation was performed using a size 9 tube. When attempting to place a 7 F EBB using fiberoptic bronchoscopy (FOB), TB was observed to the right of the right main bronchus (Figure 1). EBB (Hangzhou Tappa Medical Technology CO., Hangzhou, China) was successfully placed in the left main bronchus without difficulty. The cross-clamp time was 114 min, the cardiopulmonary bypass time was 151 min, and the anesthesia duration was 450 min. A CABGx3 procedure was performed. The EBB was removed at the end of surgery. The patient was transferred to the intensive care unit (ICU). The patient was monitored in the ICU for 1 day, followed by 5 days in the general ward, and was discharged without complications.

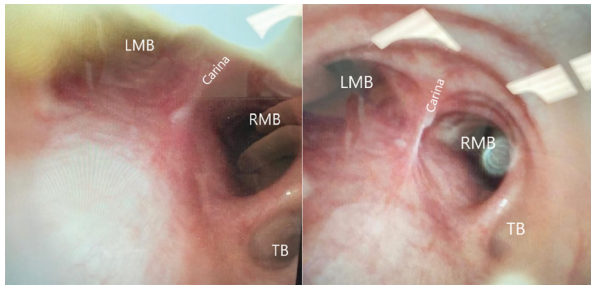

Figure 1. Fiberoptic bronchoscopy image of the patient. The tracheal bronchus was determined as type III according to Conacher's classification.

LMB, left main bronchus; RMB, right main bronchus; TB, tracheal bronchus.

Discussion

Tracheal bronchi often receive incidental diagnoses, as in this case, and can complicate lung isolation, rendering it inadequate.[10] During endotracheal intubation, bronchial lumen occlusion can lead to atelectasis, pneumonia, respiratory failure, and inadequate ventilation.[11] To address this, particularly in right lung isolation, tools such as the Fogarty embolism catheter, double-lumen tube (DLT), or Rüsch EZ-Blocker can be used.[6,10] Our patient's preoperative CT scan revealed no abnormalities, except for linear atelectasis in the left middle lobe (Figure 2). Therefore, the diagnosis of TB was established intraoperatively with bronchoscopic guidance during BB placement. Despite this, we did not encounter any issues with placing the left EBB or maintaining anesthesia. The patient was extubate at the sixth postoperative hour, and discharge occurred without the development of pulmonary complications.

Postoperative pulmonary complications are commonly cited as significant causes of morbidity and mortality, particularly after major surgeries.[12] Most MICS procedures performed

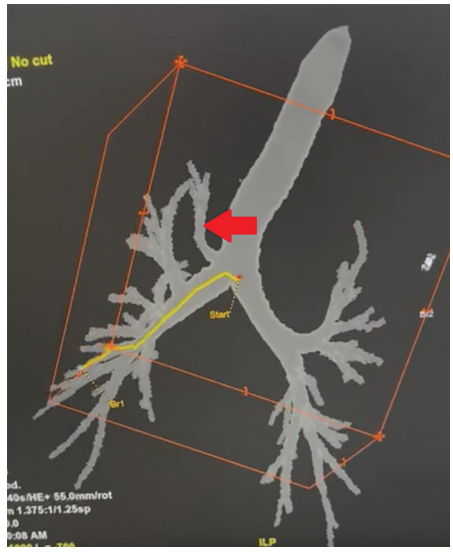

Figure 2. Computed tomography image of our patient's tracheal bronchus. The tracheal bronchus (red arrow) is located as the right apical posterior segment.

via thoracotomy involve OLV, requiring the patient to be positioned supine or with a slightly elevated hemithorax, both of which increase the risk of hypoxemia. Therefore, a thorough respiratory system assessment is necessary.[2,13] Although our patient did not have chronic lung disease, the presence of TB suggests an increased risk of respiratory complications. Nevertheless, lung isolation using an EBB under FOB guidance, along with the implementation of a lung-protective ventilation strategy, mitigated postoperative respiratory distress.

Rarely encountered, TB, especially when unnoticed in situations requiring specialized airway management, can negatively impact patients' recovery processes.[11] These situations include the methods for lung isolation necessary for OLV. In patients with TB, the primary choice for ensuring successful OLV is the use of a DLT.[14] While a well-placed left DLT may not pose issues in patients with TB, problems may arise if the TB's anatomical localization does not align with the tracheal opening of the DLT, leading to difficulty in ventilating the right upper lobe. Although this may not present problems in the early stages, shunt-related hypoxemia and postoperative pulmonary complications may arise in the later stages of surgery. However, the use of BB is advantageous over DLT in difficult intubation situations in small adults or children and eliminates the need for a tube exchange when postoperative mechanical ventilation is essential.[14] In our clinic, where we have experience with both FOB and EBB in MICS, we prefer the use of EBB. This preference is based on the fact that EBB eliminates the need to change endotracheal tubes for postoperative ventilation, resulting in less airway trauma.[15]

This issue can also be problematic not only in cases requiring lung isolation but also in surgeries performed using a single-lumen tube. If TB is located more proximal in the trachea and a tracheal tube is advanced more distally, patients may not present with intraoperative symptoms but may increase the risk of right upper lobe atelectasis and pneumonia in the postoperative period.

Conclusion

In MICS, while a comprehensive respiratory system assessment is performed, it is crucial to conduct detailed CT evaluations. Even if anomalies, such as TB, are not detected radiologically in patients undergoing OLV, they can be identified through FOB application, thereby preventing potential complications.

Ethics

Informed Consent: A patient undergoing minimally invasive coronary artery bypass grafting through informed and consented left thoracotomy was evaluated for perioperative findings.

Author Contributions: Surgical and Medical Practices - E.N.Z., N.S., A.Ö.; Concept - E. N.Z., N.S., A.Ö.; Design - E.N.Z., N.S.; Data Collection or Processing - E.N.Z., N.S., A.Ö.; Analysis or Interpretation - E.N.Z., A.Ö.; Literature Search - E.N.Z., N.S.; Writing - E.N.Z., N.S.

Declaration of Interests: The authors have no conflict of interest to declare.

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Case Report
Regional Anaesthesia

Turkish Journal of Anaesthesiology & Reanimation

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Novel Serratus Posterior Superior Intercostal Plane Block Provided Satisfactory Analgesia after Breast Cancer Surgery: Two Case Reports

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Abstract

The serratus posterior superior intercostal plane (SPSIP) block is a novel technique recently described for thoracic analgesia. This study presents two cases using this technique for postoperative pain after mastectomy with axillary lymph node dissection. The SPSIP block was administered to the patients in the preoperative period as part of multimodal analgesia, and postoperative pain was monitored using the numeric rating scale (NRS). In both patients, the NRS pain scores were below 3/10. SPSIP provided adequate postoperative analgesia in these cases without the need for any opioid agents. Thus, an SPSIP block can be a valuable treatment option for postoperative pain after breast surgery.

Keywords: Analgesia, breast cancer nerve block, pain, perioperative care, regional anaesthesia

Main Points

- The serratus posterior superior intercostal plane block is a newly defined superior trunk block.
- This block, which is applied from the medial side of the scapula, provides analgesia for the ipsilateral hemithorax and axillary region.
- This block may be an effective alternative analgesic method for breast surgeries that include axillary lymph node dissection.

Introduction

The serratus posterior superior intercostal plane (SPSIP) block is a novel regional technique for thoracic analgesia described by Tulgar et al.[1] in 2023. Their cadaveric study demonstrated that the dye spread from the 7th cervical vertebra to the 7th thoracic vertebra following the injection of 30 mL of methylene blue into the fascial plane between the serratus posterior superior and intercostal muscles. In patients with myofascial pain syndrome, the block provided analgesia for both the anterior and posterior hemithorax.[1]

This study included two patients who received SPSIP blocks for elective unilateral-modified radical mastectomy with axillary lymph node dissection.

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Case Presentation

The first patient was a 54-year-old female, and her ASA physical status was II because of hypothyroidism. The second patient was a 46-year-old female with an ASA physical status of I. Both patients signed informed consent forms for inclusion in the study. After standard monitoring and intravenous (IV) access were provided to the patients, SPSIP block was performed in the sitting position under sterile conditions as previously described.[1] To help lateralize the scapula, the patient was directed to hold their opposite shoulder using the hand on the surgical or blocked side. A linear ultrasound probe was positioned along the sagittal plane to the medial border of the scapula. Upon identification of the second and third ribs, trapezius, rhomboid, serratus posterior superior, and intercostal muscles, as well as the pleura, a 30 mL injection of 0.25% bupivacaine was administered into the interfascial plane between the serratus posterior superior and intercostal muscles. The diffusion of a local anaesthetic to the cephalad and caudad in the interfascial plane was visualized using ultrasonography (Figure 1). Routine anaesthesia induction using intravenous lidocaine, fentanyl, propofol, and vecuronium bromide was performed. At the end of the surgery, 50 mg of dexketoprofen, 4 mg of ondansetron, and 40 mg of pantoprazole were intravenously administered. The total surgical duration was 100 and 130 min. The numeric rating scale (NRS) assessed postoperative pain at minutes 15 and 30 and 1, 2, 6, 12, and 24 h after surgery. The patients received 2 IV doses of acetaminophen (1 gr/dose) at 8 h intervals for postoperative analgesia. The NRS pain scores in both patients were 3/10 in the first 24 h. The patients did not require opioid analgesics, and no perioperative complications developed. Moreover, motor block was not observed in either patient.

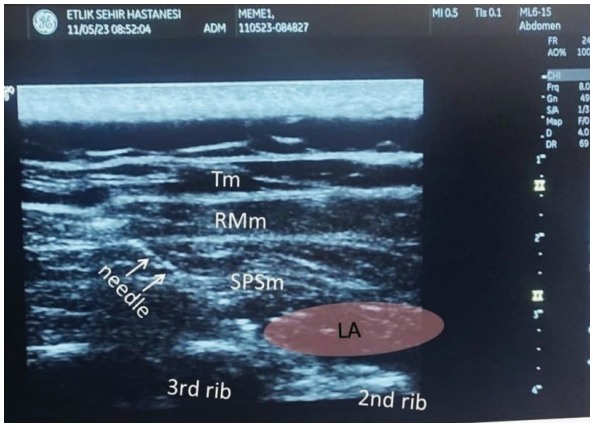

Figure 1. Local anaesthetic infiltration into the plane between the serratus posterior superior muscle and intercostal muscle.

Tm, trapezius muscle; RMm, rhomboid major muscle; SPSm, serratus posterior superior muscle; LA, local anaesthetic.

Discussion

In breast cancer surgery, regional techniques are an important part of postoperative pain management for chronic pain prevention and patient safety.[2,3] The breast is innervated by several branches of the thoracic intercostal and supraclavicular nerves; accordingly, regional techniques can be applied to many planes. Studies have shown that postoperative pain and opioid consumption are reduced in all procedures, including the pectoral nerve, paravertebral nerve, serratus anterior plane, erector spinae plane, and rhomboid intercostal blocks.[4,5] The SPSIP block can be investigated as a new plane block in breast surgery.

After the SPSIP block was defined and successful results for myofascial pain syndrome were obtained, a case report in which an SPSIP block was applied for acute postoperative pain was published.[6] It reported that adequate analgesia had been obtained for postoperative acute pain after breast surgery, similar to the results of this study. Because the breast is innervated by an extensive nerve network and the breast pain mechanism is complex, breast surgery requires multimodal analgesia, including regional methods.[7] This study applied preoperative SPSIP blocks and administered a nonsteroidal anti-inflammatory drug and two doses of acetaminophen to the patients postoperatively. Using this protocol, patient pain was controlled in the first 24 h after surgery without opioids.

Rhomboid block is performed at the inferior-medial border of the scapula and is a reliable peripheral block that provides analgesia between T2-T9 dermatomes.[8] There are many publications reporting that it reduces patient pain scores and opioid consumption after breast surgery.[9,10] However, there is also an article reporting acceptable pain in the axilla after axillary lymph node dissection.[11] Because the SPSIP block is more superiorly located than the rhomboid intercostal plane block, it may be more effective in analgesia of the upper thoracic dermatomes. However, prospective randomized studies are required to clarify this possibility.

The effectiveness of fascial plan blocks is multifactorial: local anaesthetic type, concentration and volume, patient age, use of muscle relaxants, and surgical injury. In a report describing the SPSIP block, 20 mL, 30 mL, and 40 mL 0.25% bupivacaine were used for 5 patients and they obtained similar sensory block findings.[1] In a recently published study, Avci et al.[12] performed SPSIP with 30 mL 0.25% bupivacaine for thoracoscopic surgery and demonstrated effective analgesia. To provide effective analgesia and avoid toxic effects, we preferred to use 30 mL 0.25% bupivacaine for the ship block.

It is too early to discuss the advantages and disadvantages of the SPSIP block for breast surgery because high-quality

randomized controlled studies or meta-analyses have not been published. However, two main advantages can be identified; the injection site is away from the surgical area, and the block provides analgesia for the entire axillary area. Nonetheless, patients may feel numbness in the ipsilateral neck region, which may cause anxiety. This problem can be solved by providing the patient with detailed information during the pre-operative period.

Conclusion

Although the SPSIP block has had positive results in a series of patients with chronic pain, its use for acute pain management after breast cancer surgery is a very new approach. In this case study, SPSIP blocks provided adequate postoperative analgesia during the first 24 h after breast surgery. However, this approach should be further supported through randomized controlled trials.

Ethics

Informed Consent: Both patients signed informed consent forms for inclusion in the study.

Author Contributions: Surgical and Medical Practices - G.K., S.A.; Concept - G.K., S.A., Y.Ö., C.K.Ç.; Literature Search - G.K., Y.Ö., C.K.Ç.; Writing - G.K., S.A., Y.Ö., C.K.Ç.

Declaration of Interests: The authors have no conflict of interest to declare.

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Case Report
Orthopaedic Anaesthesia

Turkish Journal of Anaesthesiology & Reanimation

Turk J Anaesthesiol Reanim 2024;52(1):36-38

Combined Lumbar-Sacral Plexus Block in Facioscapulohumeral Muscular Dystrophy for Hip Fracture Surgery: A Case Report

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Abstract

Facioscapulohumeral muscular dystrophy (FSHD) is a muscular dystrophy that can affect individuals of all age groups. Its prevalence is reported to be 0.4-1 in 10,000 people. Because of the low occurrence of FSHD, anaesthetic management is primarily based on expert opinions, case reviews, or brief series. Here, we present the case of a 72-year-old woman with FSHD who underwent hip fracture (HF) surgery. To prevent respiratory compromise due to FSHD, we opted for lumbar-sacral plexus block. To the best of our knowledge, there is no information in the literature regarding the use of combined lumbar-sacral plexus block in patients with FSHD undergoing HF surgery.

Keywords: Facioscapulohumeral muscular dystrophy, hip fracture, lumbosacral plexus block, muscular dystrophy, regional anaesthesia

Main Points

- Facioscapulohumeral muscular dystrophy (FSHD) is a muscular dystrophy that affects individuals of all age groups. Its prevalence is reported to be 0.4 to 1 in 10,000 people.
- There is no established guiding principle for anesthetic management in FSHD. Based on the limited number of published case reviews, it is advisable to avoid triggers for malignant hyperthermia, and neuromuscular blockade should be used cautiously.
- We aimed to share our anesthesia experience for HF in a geriatric patient with FSHD respiratory compromise.

Introduction

Facioscapulohumeral muscular dystrophy (FSHD) is a muscular dystrophy that affects individuals of all age groups. Its prevalence is reported to be 0.4-1 in 10,000 people.[1] The typical presentation of FSHD includes selective weakness of the shoulder girdle and facial muscles.[2] Common complications include pulmonary dysfunction, cardiac abnormalities, muscle contracture, and susceptibility to malignant hyperthermia.[3]

There is no established guiding principle for anaesthetic management in FSHD. On the basis of the limited number of published case reviews, it is advisable to avoid triggers for malignant hyperthermia, and neuromuscular blockade should be used cautiously.[4]

Anaesthesia management for hip fracture (HF) can be provided with either general or regional anaesthesia. Peripheral nerve blocks are other options for providing anaesthesia for elderly and high-risk patients. Combined

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lumbar-sacral plexus block (CLSB) has been introduced as a peripheral regional anaesthesia method in HF surgery.[5,6]

We shared our anaesthesia experience with HF in a geriatric patient with FSHD respiratory compromise.

Case Presentation

A 72-year-old female, weighing 70 kg, with a medical history of FSHD and hypertension, classified as American Society of Anesthesiologists Physical Status III, was scheduled for left HF surgery for intertrochanteric fracture repair. The patient was diagnosed with severe FSHD at the age of 45 years, experiencing respiratory muscle weakness necessitating bilevel positive airway pressure ventilation and severe muscle wasting.

In 2019, the patient underwent an appendectomy under general anaesthesia, after which she had an extended stay in the intensive care unit (ICU) and required mechanical ventilation support. The patient refused to receive general anaesthesia because of this experience. Central neuraxial blocks were not technically possible because of previous scoliosis surgery. Consequently, CLSB was planned. Written informed consent was obtained from the patient for the publication of this report.

In the operating room, vital signs were monitored. Oxygen supplement via nasal cannula flow (2-3 L h) was given to the patient. Midazolam (1 mg) and fentanyl (25 µg) were intravenously administered before positioning to make the patient more comfortable.

The patient was placed in the lateral decubitus position, with the operated side on the upper side. We performed all peripheral nerve blocks under ultrasound guidance (GE Logic P9, Gyeonggi-do, Republic of Korea), combined with a nerve stimulator (Stimuplex DIG/HNS11; B. Braun, Melsungen, Germany), and selected a 10 cm 22G needle (BBraun, Melsungen, Germany).

Lumbar plexus block was performed using the Shamrock approach.[7] The kidney, psoas major, quadratus lumborum, erector spinae muscles, transverse/spinous processes, and vertebral body were visualized (Figure 1). Contact between the needle tip and the transverse process during needle insertion was avoided by slightly tilting the probe caudad until the transverse process disappeared and the bulging edge of the vertebral body together with the psoas muscle was visualized. Using a nerve stimulator, an appropriate needle position was adjusted and confirmed as having a quadriceps contraction with a stimulating current of 0.5 mA. Following this, 15 mL 2% lidocaine, 10 mL 0.5% bupivacaine, and 5 mL 0.9% NaCl were injected.

In the same position, an ultrasound-guided parasacral parallel shift approach was performed for sciatic nerve block as described by Bendtsen et al.[8] The transducer is aligned between the posterior superior iliac spine and the midpoint of the line connecting the posterior superior iliac and the greater trochanter and the iliac bone line identified. The transducer is moved inferomedially with a parallel parasacral shift. When the transducer beam arrives at the sciatic notch, the ultrasonographic continuity of the iliac bone line is interrupted. This is exactly where the sacral plexus exits the pelvis (Figure 2). A 0.5 mA stimulating current was used to verify the sciatic nerve by observing foot plantar flexion or dorsiflexion. Following this, 10 mL of 2% lidocaine and 10 mL of 0.5% bupivacaine were injected.

After the block performances, the patient was placed in the supine position. Thirty minutes after the block performance, sensory block testing on ice was used, and surgery was allowed to start. At the beginning of surgery, she had some pain; therefore, an additional 25 µg fentanyl intravenous (IV) was administered. Subsequently, she did not express any pain at any point during the procedure.

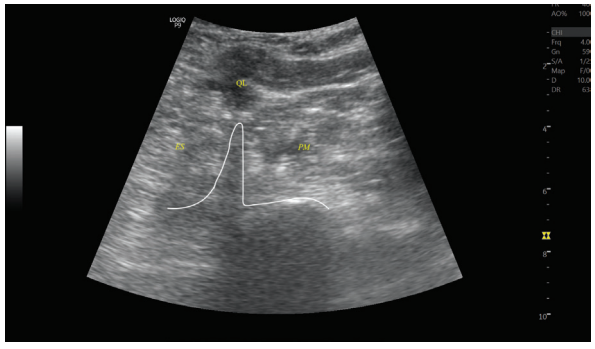

Figure 1. US anatomy of the left lumbar region at the level of the L3 transverse process in the shamrock view. The shamrock view with three leaves consists of the erector spinae (ES), quadratus lumborum (QL), and psoas major muscles (PM) and the transverse process of the L3 vertebral body (VB).

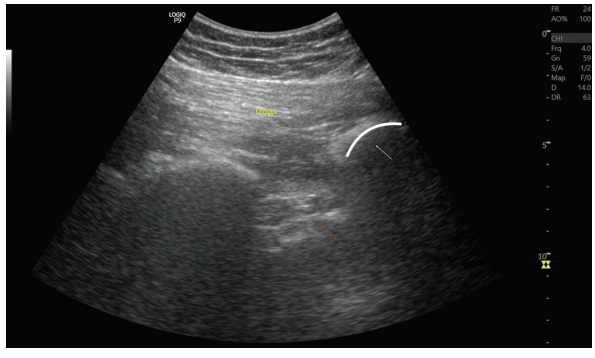

Figure 2. Gluteus maximus muscle (Gmax), sacral bone (yellow arrow), and hyperechoic sacral plexus (red arrow).

The procedure lasted 55 min. The patient stayed in the intensive care unit one night for a close follow-up. The patient needed NIMV support at night. Fentanyl patient-controlled analgesia IV (no background infusion, 10 µg bolus dose, 10-minute lock-out time) was administered to the patient. Additionally, she received 3x1 g acetaminophen. The postoperative visual analogue scale scores ranged from 0 to 1. During the first 24 h postoperatively, total fentanyl consumption was 20 µg. The patient did not have any respiratory compromise postoperatively. There were no postoperative complications. On the fifth day following surgery, the patient was discharged uneventfully.

Discussion

FSHD may present with a variety of symptoms, and its progression is also variable. Extramuscular manifestations of FSHD are rare. Clinically significant respiratory insufficiency occurs in 1% of patients with FSHD.[9,10] Nevertheless, special attention is necessary. Regional anaesthesia techniques may be a suitable choice for anaesthesia management in FSHD.

The patient refused general anaesthesia because of a previous long ICU stay after appendectomy surgery under general anaesthesia. To avoid respiratory failure, malignant hyperthermia, and use of neuromuscular blockade, we preferred the regional anaesthesia technique in this case.

The patient underwent scoliosis surgery with T2 iliac wing posterior stabilization and fusion with L3-L5 and Th4-Th6 vertebroplasty. Whether corrected or uncorrected, the anatomical anomalies of scoliosis can hinder the placement and effectiveness of neuraxial anaesthesia.[11] Neuroaxial blocks were not technically possible; therefore, we did not consider them as a first-line choice.

Therefore, we performed lumbar and sacral plexus nerve block combination. In the beginning, the patient had some pain, which was relieved by the addition of 25 µg of fentanyl. Because of the lack of sensory block of T12, partial failures could be observed in the lumbar and sacral plexus nerve block combination. A low- dose systemic analgesic may be required in these cases. Following this, all procedures were completed without pain. We did not encounter any hemodynamic disturbance during surgery. The patient was comfortable breathing spontaneously with oxygen supplement via nasal cannula flow of 2-3 L h.

Conclusion

The combination of lumbar and sacral plexus block may offer reliable surgical anaesthesia, adequate postoperative pain control, and reduced risk of HF surgery complications in geriatric patients with FSHD-related respiratory compromise.

Ethics

Informed Consent: Written informed consent was obtained from the patient for the publication of this report.

Author Contributions: Surgical and Medical Practices - İ.K., C.C.G., M.A.D.; Concept - M.M.; Design - M.M., Y.G.; Data Collection or Processing - İ.K., C.C.G.; Analysis or Interpretation - M.M., M.A.D., Y.G.; Literature Search - İ.K.; Writing - M.M., İ.K.

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